E67
.3
LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

CONSEIL PERMANENT INTERNATIONAL
POUR L'EXPLORATION DE LA MER

JOURNAL DU CONSEIL

VOL. VII · NO. 3

PUBLIÉ PAR LE BUREAU DU CONSEIL

RÉDIGÉ PAR

E. S. RUSSELL

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

DECEMBRE 1932

Note.

The Journal of the Council will in future appear *three times a year*, and three numbers will form a volume. It will include, in addition to general articles, reviews and bibliography, the special papers hitherto issued in the series of "Publications de Circonstance".

The annual subscription price has been fixed at 12 Kroner (+ Kr. 1.50 for mailing expenses) per volume, which will include, if desired, a reprint of the bibliographical matter, printed on one side of the paper. Single copies will be sold at Kr. 4.50.

Contributions to the Journal should be addressed to: —

The Secretary
Journal du Conseil,
Fisheries Laboratory,
LOWESTOFT, England.

They may be written in English, French, German or Spanish. General and scientific articles must be accompanied by a summary. General articles and reviews will be paid for at the rate of 10 Kroner a page. Authors of general articles and scientific papers will receive 50 copies of their paper gratis. Typescripts and figures should be submitted in a state fully prepared for press, in order that the costs of proof correction may be reduced to a minimum, and no expense be incurred by the Council in re-drawing any figures. Reviews should not exceed 600 words (one page). *Contributors are requested to follow the instructions printed at the end of the number.*

Correspondence, as well as books and papers for review or bibliographical notice, should be addressed to the Secretary.

Orders for copies should be sent to Messrs. Andr. Fred. Høst & Søn, Bredgade, Copenhagen.

CONSEIL PERMANENT INTERNATIONAL
POUR L'EXPLORATION DE LA MER

JOURNAL DU CONSEIL

VOL. VII · NO. 3

PUBLIÉ PAR LE BUREAU DU CONSEIL

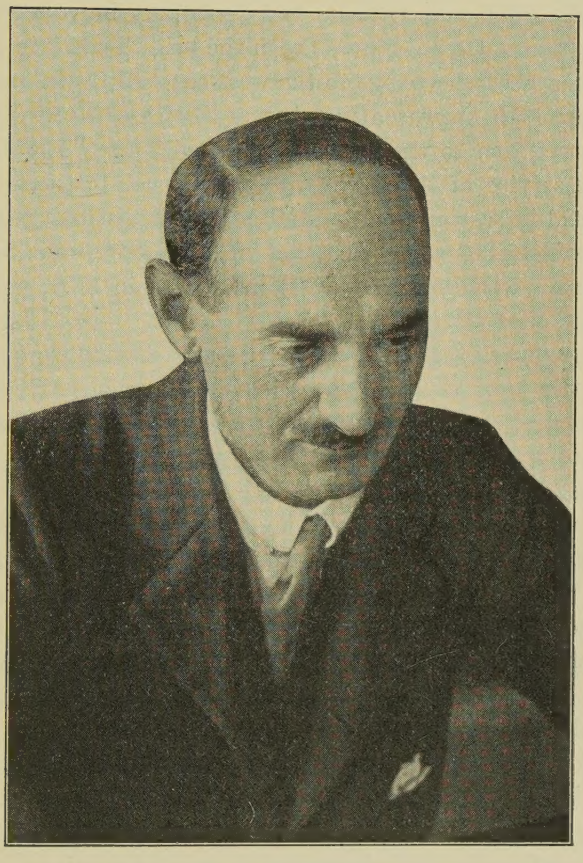
RÉDIGÉ PAR

E. S. RUSSELL

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

DECEMBRE 1932

IMPRIMERIE BIANCO LUNO A/S



J. N. Nielsen.

(1877–1932).

JENS NICOLAI NIELSEN was born 4. Nov. 1877 in Klim in Northern Jutland. He passed exam. art. in 1896 and took the degree of B. Sc. (cand. mag.) in physics at the University of Copenhagen in 1902. The international oceanographic researches began in the same year, and NIELSEN was appointed assistant hydrographer

under the Danish commission for the study of the sea, and took part as hydrographer in the voyages of the Danish research steamer "Thor" to the Faroes and Iceland in 1903, 1904 and 1905.

In 1905, 1906 and 1907 he also took part in voyages to the Eastern Atlantic Ocean. He was with the brig "Tjalfe" in 1908 and 1909 on her research voyage to the west coast of Greenland. In the summer of 1910 he was a member of Professor JOHS. SCHMIDT's second expedition to the Mediterranean with the "Thor". He entered the service of the Danish Meteorological Institute in 1910, and in 1923 he was appointed State meteorologist and chief of the weather office. He was a member of Professor JOHS. SCHMIDT's first "Dana" expedition in the Atlantic ocean in 1921, and also of the second in 1928.

These many voyages in waters of widely varying character gave him practice in observation and scientific experience. He was born with powers of combination and a critical sense, and he had ample occasion to practice the latter in the literary studies which preceded his published works.

These published works are not very many. With the exception of a single treatise which deals with a drift-bottle experiment and a single theoretical dissertation about the rise of temperature in downward-moving water all NIELSEN's works have their origin in the observation of distribution of temperature and salinity in suitable sections, and in comparison of different sections. His first works are from Iceland and the Faroes. Here he specially studied the anticyclonic current which moves round Iceland, and the Irminger current extending into Denmark Strait. These researches were continued during the voyages of the "Tjalfe". On these cruises he studied the waters round Greenland, especially the East Greenland Polar Current, which bends round the south point of Greenland and on the west coast gradually changes to a relatively warm coastal current. South of Greenland he also found convection currents, arising from cooling of the surface in winter and extending down to the bottom, thus forming the cold bottom water of the North Atlantic.

NIELSEN became aware of a Mediterranean problem in 1905, when the Danish research voyages, on account of the eel researches, were extended farther south. He described in a treatise in 1907 a

warm and salt water-stratum found at a depth of about 1000 m. near Ireland, which he supposed was originally water which had streamed out from the Mediterranean through the Straits of Gibraltar. This current had already been observed by CARPENTER. NIELSEN began to work in earnest on the hydrography of the Mediterranean when, after the "Thor's" first Mediterranean voyage 1908—09, he received the hydrographic material to work up. He wrote a short article about this in the Danish "Geografisk Tidsskrift", which led to his becoming a member of the "Thor's" summer expedition to the Mediterranean in 1909. After he had come home he wrote his chief work, "Hydrography of the Mediterranean and Adjacent Waters" (1912). This work is the result of exact observation; NIELSEN writes, for instance, that in the Mediterranean a tenth of a degree has about the same importance in indicating changes as a whole degree in the Atlantic. The work shows his great hydrographic experience and his clear, sober thinking. We shall not attempt to give an account of this work, which has attracted so much attention by the many new and surprising results it contains; let it suffice to say that NIELSEN gives a survey of the movements of the waters in *the whole* of the Mediterranean from east to west, from bottom to surface. He makes it clear that the principal factor in the hydrography of the Mediterranean is evaporation from the surface. The evaporation uses up water and leaves the surface water more saline; herein lies the cause of the inward current through the Straits of Gibraltar and of other horizontal currents, the increased salinity setting convection currents in motion, which again cause horizontal water-movements. NIELSEN has made himself a fine monument in his treatment of the hydrography of the Mediterranean. The work has been a good deal commented on, and it still sets pens moving.

There remains a short treatise on the "Dana's" voyage in the Atlantic Ocean in 1921. It deals with the Gulf Stream (Geogr. Tidsskrift, Copenh. 1925), and describes the stream's formation and the water strata which form it. He maintains that the warm and salt water which washes the coast of North-West Europe is undoubtedly derived mainly from the Antilles Current, the water masses of which keep outside the Antilles Islands and farther north run on the right-hand side of the Florida current. And by this

latter name the Gulf Stream proper, coming from the Gulf of Mexico and running through the Florida straits, ought to be designated.

Nielsen was an independent and original personality. He was probably best known to those who had sailed with him, and he will not be forgotten by them. Sometimes it would happen that he sat long silent and listened to the conversation, and then suddenly he would utter a short remark, which at times could have the double effect of causing hearty laughter and at the same time disclosing a new truth. His opinions had firm foundations; they were the result of thinking and not of feeling, and therefore he was a judicious adviser, even if his words at times could be somewhat caustic. Perhaps people who did not know him well feared him a little; but to old acquaintances he was an understanding and honest friend. His death (on 15. Aug. 1932) meant the loss of a highly gifted scientist, a gentle mind, and a valuable personality.

Ove Paulsen.

Phytoplankton. Methods and Problems.

By

H. H. Gran.

The study of the phytoplankton of the sea had a period of stagnation after the survey of the distribution of the species had been practically finished, at least in the North Atlantic waters. The problems on the quantitative distribution raised by HENSEN and BRANDT and on the conditions of growth and decrease of the various species could not be solved as long as the methods for determination of the nutrient salts were insufficient. With the introduction of the colorimetrical methods by ATKINS and HARVEY the possibility has been opened for a rational investigation of the factors governing the productivity of the sea. It may therefore be useful to give a short review on the biological methods in use, their advantages and limitations, and on the actual problems, as far as they can be attacked with the methods we now have.

Methods.

For qualitative purposes the method of collecting plankton samples by towing fine-meshed silk nets vertically or horizontally has given good service. This method has given the first orientation of the distribution of the various species through the year and their migration with the currents. But for quantitative purposes, for the estimation of the productivity of the sea and the growth under different physical and chemical conditions, it is necessary to be able to determine the number of cells of each species living in a unit volume of water at a distinct depth, where the physical and chemical factors can be accurately determined. Water samples can be collected for this purpose by a water-bottle or a pump, and the living content can be concentrated for counting under the microscope by a centrifuge, filtration or by sedimentation.

The centrifuge was introduced for marine investigations by LOHMANN (1908), who found that it could be used with sufficient accuracy by centrifuging water samples as small as 10 to 50 cc. in coastal waters. In the open ocean it may be necessary to use a centrifuge with a capacity of 300 cc. (GRAN 1912 a, LOHMANN 1920). LOHMANN demonstrated the great advantage of the method in that it allows for the determination also of the minute species which escape through the meshes of even the finest silk nets, the "Nannoplankton".

LOHMANN and later HENTSCHEL (1932) centrifuged the water samples taken directly from the water-bottle and determined the species in the living condition. This method has a distinct advantage for the identification of minute species, particularly of naked cells, which in preservation may lose their colour and easily escape observation. It can be used with advantage either where the observations are repeated regularly — with sufficiently long intervals — at one single coastal station, or during longer expeditions in the open ocean, where the conditions are so uniform that it may be sufficient to make one hydrographical station per day, leaving time to work up water samples taken from three or four different depths at the same station, until new material is collected. But in other cases the material which can come under observation by this method is quite insufficient. Particularly in coastal waters the hydrographical conditions can vary within short distances, and with them the qualitative and quantitative composition of the plankton, so that it may be necessary to make three or four stations per day in order to obtain an adequate picture of the situation. It will also be necessary to collect a series of samples from various depths at each station, as the different layers covering each other may have their distinct plankton. After a period of growth the plankton may be sinking and accumulating at a certain depth below the surface, or the water layers may have been mixed vertically with the result that the plankton is evenly distributed from the surface to a certain depth. If the collection of samples is limited to the surface, or too few samples are collected at each station, such important facts may easily escape observation.

Fortunately it is possible to preserve water samples for future examination. Preservation with Flemming's solution (GRAN 1912 b) is excellent for all forms except the Coccolithophorida with their calcareous shells. SCHILLER (1914) and WULFF (1926) introduced neutralized formalin, which is recommended because it preserves the calcareous forms also, and even the infusoria are sufficiently well preserved to be identified, even if their cilia are less distinct than after preservation with Flemming's solution. Samples preserved with Flemming's solution keep about one year, with formalin at least two or three years.

Within certain limits this method has proved itself satisfactory. Species which occur with a frequency of only a few cells — or chains — in the volume of water centrifuged, cannot be determined quantitatively with sufficient accuracy, and they may even escape observation, if they are very scarce. Unfortunately it is as a rule necessary, particularly in coastal waters, to limit the volume of the centrifuged water samples to 50 cc. When larger samples are centrifuged, the drop below the cover glass will be too crowded with plankton and still more with dead sediments of organic or inorganic origin to allow for exact quantitative examination. When it is desirable to have more exact figures for the frequency of larger species, e. g. of Ceratia, when they are less frequent than 200 per litre, the centrifuge method may be supplemented by filtering larger water samples of known volume through silk nets. The samples may be collected either by large water-bottles (W. E. Allen) or by a pump as used by Birge and Juday (1922).

The centrifuge method of course has its limitations. E. J. Allen (1919) has found from his dilution cultures that sea water may contain 30 times the number of living cells determined by the centrifuge method. I have repeated his experiments and obtained corresponding or similar results. Not only small flagellates but also some diatoms, particularly *Nitzschia delicatissima*, appeared to be more abundant in the dilution method than was indicated by the centrifuge method. It will be useful to obtain more observations under various conditions to determine the range of the sources of error of the method for the different species. But as it is, the centrifuge method gives the actual variations in the quantitative occurrence of the most important species, even if the figures obtained may be only relative. Moreover, these variations are so wide that even an error of 50 % may be allowed for.

The accuracy can be increased, for example, by repeated investigations, but as the time devoted to an investigation must be limited, better results may be achieved from a larger number of less accurate determinations than from a limited number of accurate observations. As the plankton content of a body of water is always changing through reproduction, serving as food for other organisms and through sinking, we now need most of all a broad picture of the situation and its changes, only to be achieved by an easy working method. And, with all its limitations, the method is still the best we have.

W. E. Allen (1928) determines the number of cells living in a measured quantity of water collected in a water-bottle and filtered through a fine silk net. An aliquot part of the sample is observed in a 1 cc. Sedgwick-Rafter chamber, and the cells are counted. For a number of species this method will give the same accuracy as the centrifuge method, but

it has two disadvantages: 1) the nannoplankton escapes through the net, and 2) the thickness of the chamber does not allow for the use of a sufficiently high power to determine with certainty some of the more difficult species. Recently UTERMOEHL (1931) has introduced a method of sedimentation, using for the purpose a specially constructed microscope to observe from beneath and count the plankton organisms sedimented at the bottom of cylindrical tubes. For freshwater samples he recommends the killing of the cells by adding a few drops of an iodine solution. This new method may certainly be very useful, but I have not yet had an opportunity to test whether it will be an improvement for marine work.

No method can give the total plankton content of a body of water, and even if this could be achieved, the scientific value would not correspond to the amount of work it would require. The various species differ widely in size, in metabolism and in rate of reproduction. The total sum of all species could not be used to measure the productivity of an area of the sea any better than the study of the growth and decrease of the dominant species.

In some cases it is possible to obtain an approximate value for the total plankton production of an area during a shorter period by studying the quantity of oxygen liberated by the photosynthesis of the algae or by the quantity of phosphates absorbed from the sea water. The oxygen determinations can only give a minimal value, as a portion of the oxygen produced by the phytoplankton is consumed by animals and bacteria, and, where the surface waters are supersaturated, another part may be given off to the atmosphere. The method can only be used where the phytoplankton is predominant, as during the abundant spring growth of diatoms in the coastal waters of Northern Europe (GAARDER and GRAN 1927, GRAN 1927). A better method is perhaps the determination of the variations of the phosphate content of the surface layers. I have tried it in the coastal waters of Norway (1930) and in the Antarctic (1931), and recently KREPS and VERJBINSKAYA (1930, 1932) have used this method with great success in the Barents Sea.

The variations of the nitrate content might be used in the same way, since, as a rule, they run parallel to those of the phosphates. However, as the phytoplankton can also use ammonia as a source of nitrogen, the variations of the phosphates will give more reliable results. Investigations of phytoplankton should in future always be accompanied by observations of the phosphate and oxygen content of the same water sample from which the plankton samples are taken. Nitrate determinations are of course desirable but if it is necessary to limit the number of observations, the phosphate determinations are to be preferred.

Culture experiments. The dilution method of E. J. Allen (1919) has been used with success as a valuable control of the centrifuge method for quantitative investigations. As a method of determining the plankton content of water samples it is, on the other hand, very limited in its application. It can only be used in a good laboratory for water samples collected in the immediate neighbourhood, and only for very few samples at a time. Another disadvantage lies in the fact that not all species grow equally well in the small bottles. The majority of diatoms, at least the neritic species, grow well, as do also the flagellates and even *Pontosphaera*, but most of the Peridiniales do not grow at all. But the dilution method is very valuable indeed for providing pure cultures of the species which on any occasion occur in the greatest numbers.

Allen and Nelson (1910) obtained pure cultures by sedimentation of plankton diatoms in Petri dishes containing sea water diluted with sterile sea water. The sedimented diatoms grew to form visible colonies which could be isolated and transferred by a capillary pipette into bottles containing sterile sea water. The only difficulty was that the colonies were easily infected by motile species, particularly by *Nitzschia closterium*.

The cultures obtained by these methods may of course contain bacteria, which are removed with great difficulty, since the plankton species do not grow on agar plates, as many of the littoral species easily do. Schreiber (1928) isolated single cells of *Biddulphia mobiliensis* by sterile pipettes and washed them by an ingenious method with sterile sea water, filtered through a Seitz filter, to free them from bacteria. He could then use these pure cultures to study the propagation under different intensities of light and to determine their light optimum. He also used pure cultures of *Carteria* and *Chlamydomonas* to determine the nitrate and phosphate content of sea water samples as a control for the direct chemical methods introduced by Atkins and Harvey. Later Braarud and Føyn (1931) used absolutely pure cultures of *Chlamydomonas* to determine the quantities of organic substance liberated into the sea water.

Pure cultures of the diatom *Coscinosira polychorda*, provided by E. J. Allen, were used by Marshall and Orr (1928) to determine the photosynthesis and respiration at different depths in Loch Strivan by suspending closed bottles at various depths in the sea and determining the changes in their oxygen content after three or four hours. Raw cultures of phytoplankton can also be used for the same purpose, where and when the sea water is rich in diatoms, as shown by Gaarder and Gran (1927). Such raw cultures have also been used to determine the rate of growth of plankton algae, with or without the addition of various nutrient salts. If the original plankton content of the water is not too

dense, the life conditions may be normal in three to six days, as long as the population in the bottles has a density below 1000 diatom cells per cc. (GRAN 1931).

Problems.

The taxonomy and general distribution of the plankton algae obtained by nets is now worked out in the Northern Atlantic, at least for the most important species. Some species occur in the centrifuged samples, which have yet to be accurately described, particularly some flagellates and small brown Peridiniales, which at times may be very abundant, and some of the ciliated infusoria. Some of the latter, such as *Mesodinium*, and some species of *Laboea* live in symbiosis with small brown cells and may occur rather abundantly in the plankton.

Our knowledge of the life history of the plankton algae is yet incomplete and many questions are still open. Reproduction in most of the species occurs by the process of ordinary cell division. The process of sexual reproduction is insufficiently known. Gametes have been observed in some diatoms, but the development of the zygotes is unknown. Resting spores occur regularly in a number of species, but the conditions necessary for their formation have not been studied, and their germination is unknown. It should be possible, however, to solve these questions with the culture methods now at our disposal.

Actually the most important problems are those concerned with the factors determining the relative productivity of the various areas at different seasons, such as temperature, light, and the distribution and circulation of the nutrient salts.

Temperature, more perhaps than any other factor, determines the growth and decrease of the various species and the character of the communities dominating the plankton. But some species are adapted even to the most extreme temperatures found in the sea, and a rich growth can take place as well at the lowest (—1.5°) as at the highest temperatures observed. The salinity, too, seems to have a great influence on the general character of the plankton. A number of the oceanic species seem to be dependent on the uniform osmotic conditions characteristic of the open ocean, but as a rule a more abundant life is found in coastal waters where the salinity is more variable, and a rich growth is possible even in brackish waters, though the plankton community will be limited to a very few species.

One may be permitted to conclude that light is the limiting factor even at the surface during the dark season in higher latitudes, but even in the North Polar Sea a rich diatom plankton grows in the short summer,

as was found by NANSEN on the "Fram" (GRAN 1900) and SVERDRUP on the "Maud". In the Denmark Strait, BRAARUD observed a rapid growth taking place between the ice floes as soon as the ice broke in the month of June, and in the Karajak Fjord (W. Greenland) in 70° N. latitude. VANHOEFFEN (1897) found diatoms already growing on the underside of the ice in March.

Information regarding the depths at which the light is still sufficient for the photosynthetic activity of the plankton algae is scarce. The observations made on various expeditions concerning the vertical distribution of the algae, such as those of the "Valdivia" expedition and even LOHMANN's detailed observations on the "Deutschland" give no sufficient evidence, as we know that the algae can sink far below the limit where they find just sufficient light for their photosynthesis, and that they are capable of existing in an inactive condition, without propagation, for a long time. As a striking example, I found in the lake Mjøsen, Norway, in the month of March, while the surface was covered by a thick layer of ice, several hundred cells per litre of *Melosira* at 300 to 400 metres depth. When SCHIMPER on the "Valdivia" in the Antarctic found the maximum occurrence of diatoms at 40 to 80 metres depth (KARSTEN 1905), they must certainly have been sinking, as we know that no effective photosynthesis can take place in these latitudes below 50 m. depth. The question can only be solved by culture experiments in connection with light measurements, or in some cases by oxygen and *pH* determinations.

The most important results achieved up to the present time are those of MARSHALL and ORR (1928). In Loch Strivan they found the balance depth to be at about 30 m. during summer and at 10 m. or less during winter. The thickness of the productive layers must of course vary with the latitude, the season and the transparency of the water. In the open ocean I have concluded from the vertical distribution of the oxygen that the balance depth should be at about 50 metres at 60° latitude (GRAN 1929). We have as yet no observations from the tropics, where it certainly lies much deeper. It should be possible to get nearer to a solution by combining exact light measurements by the method introduced by POOLE and ATKINS (1926) with physiological experiments, to determine the minimum of light intensity at which photosynthesis can balance respiration at different temperatures for the various physiological types. The greatest progress of late in the study of the productivity of the sea has been achieved in the researches on the relation between abundance of the phytoplankton and the circulation of nutrient salts, particularly the compounds of nitrogen and phosphorus. Since the introduction by ATKINS and HARVEY of DENIGÈS' colorimetric methods to determine

phosphates and nitrates it has been possible to definitely prove Brandt's theory, that the occurrence of these nutrient salts is the most important of the factors limiting the growth of the phytoplankton. Also Nathansohn's theory of the circulation of the nitrogen and phosphorus compounds in the sea has been evidently proved. It has been demonstrated that the phosphates and nitrates are consumed by the phytoplankton in the surface layers, that the phosphorus and nitrogen compounds are gradually accumulated in the deep sea by the sinking of dead and living bodies, and are brought into circulation again:

1) by *upwelling*, as on the west coasts of America (W. E. Allen 1928 and Moberg 1928) and Africa (Hentschel and Wattenberg 1930).
2) by *turbulence* caused by tidal currents along an uneven sea bottom or through narrow straits, as in Puget Sound (Gran and Thompson 1930) and in the Bay of Fundy.
3) by vertical circulation (*convection*) during winter, when the surface layers are cooled, as along the coasts of Northern Europe.

In the first two cases the circulation must continue throughout the whole year, and the growth of the phytoplankton continues more or less evenly during the whole summer season. In the third case the greater portion of the nutrient salts is consumed by a rich growth during a short season of 4 to 6 weeks in the first months of spring. During the summer the bodies of water are so distinctly stratified that circulation of any importance is impossible.

It is a characteristic phenomenon that the phytoplankton developing under conditions where the surface layers are rich in nutrient salts (100 mg. per cbm., or more, of nitrate as N, 40 mg. per cbm., or more, of phosphate as P_2O_5), consists of diatoms as the dominant plant components. As far as we know, the diatoms exhibit the most rapid growth of all the plankton algae. Their rate of propagation can reach 300 % in 24 hours, while the *Ceratia*, for example, under optimal conditions have a daily increase of only 50 % (Gough 1905, Apstein 1910, Gran 1912 a), and as a rule considerably less. Where the waters are stratified during summer, as in the Norwegian coastal waters or in the Gulf of St. Lawrence, the spring growth of diatoms is followed by an increase of Ceratia as soon as the stratification is established. The Ceratia and other motile forms, like *Pontosphaera*, must be able to grow in water containing a lower concentration of nutrient salts than the diatoms.

In some cases the growth of the phytoplankton does not begin to be visible even when the surface waters apparently contain sufficient

quantities of phosphates and nitrates, and the light and temperature conditions should be favourable. In such cases we have to look for other limiting factors which have not yet been taken into consideration.

Stabilization. In spring, the diatom plankton begins to grow at different times even in localities where one would expect life conditions to be nearly identical. Off the Norwegian coasts in about 60° N. lat. a rich growth can be observed along the shore as early as the beginning of March. About a week later the diatoms begin to grow at the edge of the continental shelf, about 40 miles off the coast, but over the rest of the bank, between those two centres of growth, the development is retarded two or three weeks. Now, the vertical mixing of the surface layers apparently continues for a longer period over the bank than in the other localities. Braarud and Klem (1932) have taken up the idea first advanced by Atkins during a discussion in Plymouth after the meeting of the International Council in 1929, that the maximal growth cannot take place until the vertical movements are completed, because the diatoms are prevented from accumulating in the surface layers where the light is sufficient for photosynthesis.

In Puget Sound, where the phosphate and nitrate content is very high through the whole year (T. G. Thompson and Johnson 1930), but the water layers are constantly mixed vertically, the phytoplankton is scarce until the middle of May, but very rich during the whole summer (Johnson and Thompson 1929), when the surface waters are somewhat stabilized by the outflowing water from the Fraser River.

In the Bay of Fundy, too, the waters are constantly mixed by the strong tidal currents and loaded with detritus from the shallow, muddy beaches at the head of the bay, Along the north-western coast the plankton is never rich, but fairly evenly distributed from the surface to the bottom as a result of the turbulence. When the growth is poor in spite of the high phosphate and nitrate content, it must be caused by the lack of stabilization in connection with the low transparency, making the productive surface layer very shallow, probably only 10 metres or less.

In the Antarctic, where the phosphate content in the Weddell Sea is very high even at the surface, 150 mg. P_2O_5 per cbm. according to Wattenberg's and Ruud's observations, and the nitrate content as high as 500 mg. N per cbm., the plankton diatoms, mostly *Corethron valdiviae*, were in the first part of the summer season 1929—1930 fairly evenly distributed from the surface down to at least 75 metres depth, but not at all abundant. The chemical analyses showed no increase of oxygen or decrease of phosphate or nitrate as long as this situation lasted. It can be explained by supposing that a continuous vertical mixing of the surface layers was going on, and the density of the water was so

even that a vertical circulation was possible. A week before the New Year the situation began to change. The surface water became stratified and stabilized due to the melting of ice floes, the diatoms accumulated in the upper layers from the surface down to 25 metres, and about a third of the phosphates and nitrates were gradually consumed. At 40 metres depth the phosphates still showed a slight decrease, but at 75 m. apparently nothing was consumed.

All these examples show the importance of the stabilization of the surface layers. A marked stratification excludes circulation of the nutrient salts with the result that the surface layers become depleted of plant nourishment and the diatoms with their high requirements sink and disappear. On the other hand, continous vertical mixing prevents them from accumulating in the lighted zone and from utilizing the nutrient salts present to such an extent as might have been expected.

Coastal waters and open ocean. Another problem to be solved is the difference in productivity between the coastal waters and the open ocean. From his numerous observations Lohmann (1920) judged the coastal waters to be on an average 50 times richer in plankton than the open ocean. The poor growth in the open ocean of the tropics can easily be explained as due to the lack of sufficient quantities of nitrates and phosphates in the surface waters, particularly in the anticyclonic systems on both sides of the Equator, where any upward movement of the water is precluded. In higher latitudes, where vertical circulation is possible during winter, the conditions may be different.

Off the Norwegian coasts we have regularly observed that the rich growth of diatoms during spring (March—April) is confined strictly to the coastal current, while in the Atlantic waters outside the coastal bank the growth is very poor. As long as we had no observations on the nitrate and phosphate content, we tried to explain this fact on the supposition that the supply of nutrient salts necessary for the growth had to be carried out from the coast and from the Baltic. When the new methods for the determination of phosphates and nitrates became available, it was clearly shown that this explanation was insufficient, at least with regard to the nitrates and phosphates. Sund (1929), and later Braarud and Klem (1932), even found a higher content of these salts in the Atlantic waters than in the coastal current. In the Atlantic current with its uniform salinity the vertical circulation during winter is deeper than in the more stratified coastal waters. Now, it had been shown by earlier observations (e. g. Gran 1915) that also the oceanic parts of the North Atlantic can be very rich in phytoplankton later in the season, in May to July, just at the time when the coastal waters from the North Sea, from Scotland

and the Faeroes begin to drift outwards from the coasts along the surface. Similar observations were recently made by KREPS and VERJBINSKAYA (1930) in the Barents Sea. They found that the spring growth of diatoms commenced along the North European coast and simultaneously in the arctic waters near to the polar ice, but about a month later became evident in the intermediate Atlantic current and its branches, which had a higher phosphate content than the coastal water.

It is, then, an interesting problem how and why the coastal and polar waters can have a stimulating effect on the growth of the phytoplankton in the open sea. Two principal reasons may be suggested.

1) The oceanic waters may lack either some necessary nutrient material, or 2) perhaps germs oi species able to grow under the prevailing conditions.

If this stimulating effect is brought about by some nutrient salt which has to be regularly carried out from shore, it might be *iron*, judging from the experience of CARSTEN OLSEN (1929) on *Lemna minor*. In alkaline solutions such as sea water iron is only soluble in the form of organic compounds such as the "humic" substance in soil. As soon as it is liberated as inorganic ions it is oxidized and deposited as trivalent compounds, which go irreversibly out of circulation. From the "Challenger" expedition it is known that the sediments at great depths, as in the open Pacific, consist chiefly of iron and manganese compounds.

Culture experiments which I have made with raw cultures of plankton diatoms (GRAN 1931) have shown that the addition to the sea water of small quantities of garden soil extract may have an enormous stimulating effect on the growth, in accordance with similar experiences on littoral algae like *Cladophora* and *Enteromorpha*, after this method was introduced in the laboratories by E. PRINGSHEIM. Recently BURK and others (1932) have shown by exact experiments that the stimulating effect of soil extract on *Azotobacter* cultures is exclusively caused by its content of soluble iron. Probably the same is the case with the marine algae, but it has not yet been possible to solve the question definitely. Last summer, in collaboration with Dr. SELMAN A. WAKSMAN at Wood's Hole Oceanographic Institute, I had the opportunity to make some further experiments, using WAKSMAN's (1932) synthetic Ferri-ligno-protein for comparison with soil extract, and this compound, which in its chemical and physical characters corresponds closely to the "humic" substances of the soil, gave the same stimulating effect on the growth of the plankton diatoms as the soil extract. Details of the experiments will be reported elsewhere. It is evident from the results of the culture experiments that the neritic diatoms require a higher concentration of iron compounds than the

oceanic species, which have a lower rate of propagation (100 % per day for *Rhizosolenia alata* against 300 % for *Leptocylindrus danicus*).

The iron content of sea water has been determined by HARVEY (1928) as 3 to 6 mg. Fe per cbm. KLEM (BRAARUD and KLEM 1932) found off the Norwegian coast from 4 to 21 mg. per cbm., more nearer land than in the Atlantic waters outside the coast, and more in the surface waters than in the depths. Before the importance of iron as a limiting factor can be judged, we must know more about the nature of the iron compounds found in the chemical analysis of sea water, how much of the iron is present as insoluble particles, and how much is really available for the phytoplankton. In addition to iron, manganese also has to be considered.

The other possibility, that the stock of viable cells of plankton algae in the North Atlantic current may have been depleted during the winter and has to be renewed in spring from coastal or from polar waters, may be supported by a number of observations. The diatoms which increase in the North Atlantic current in May are partly oceanic species, such as *Chaetoceros decipiens*, but some of them are also neritic, and the composition of the community corresponds with its origin either from Scotland or the Faeroes (GRAN 1915). It has also often been observed that the greatest abundance of plankton diatoms occurs just at the border between Atlantic and Arctic water, and this fact is easily explained by the supposition that the Arctic water is poor, because its nitrates and phosphates have already been consumed at the surface, and that the Atlantic water is rich in phosphates and nitrates but poor in species able to propagate under the existing conditions. The abundant growth in polar seas in spring, starting as soon as the ice breaks up, may depend upon the presence of resting spores of arctic diatoms in the ice, such as NANSEN found (GRAN 1900).

It may perhaps also be taken into consideration that the thin layers of coastal waters covering the Atlantic current during the spring and summer may have a stabilizing effect on the surface waters, and thus promote the growth as mentioned above.

Most of these questions are still open, but much might be achieved by an intensive investigation *through a whole season* (March to September) of an area as important and characteristic as the North Atlantic, south and north of the Faeroe-Shetland ridge and the mouth of the North Sea. The various expeditions have compared the productivity of different areas at one season, but they may easily have obtained thereby a distorted picture of the situation, as the productive season is in many cases short and occurs at different times in different areas. The productive season in the North Atlantic seems to be in the months May, June and July.

The solution of these questions might be important not only in itself, but also in connection with the fisheries. SAVAGE (1932) recently published an interesting paper showing that the herrings in the North Sea have a distinct feeding season, May and June, and that their maximal growth takes place at that time.

The outflow of nutrient salts, nitrogen and phosphorus compounds, from the shore undoubtedly takes place to a rather large extent, but the effect of it has been overestimated as a general factor in comparison with the supply from the deep sea and may in many cases be of strictly local importance. But with regard to such basins as the Baltic, into which large rivers debouch from richly fertilized areas, and where the productivity is not very remarkable as long as the waters are brackish, it would be of great interest to study the effect of the Baltic waters on the rich growth in the transition areas, the Kattegat and the Skagerrack. Here the waters are always markedly stratified, with the exception of the inflowing current along the coast of Jutland, and the growth takes place mainly in the surface layers of low salinity.

References.

1910. ALLEN, E. J. and NELSON, E. W. On the Artificial Culture of Marine Plankton Organisms. Journal of the Marine Biological Association of the United Kingdom. Vol. VII, No. 5.

1919. ALLEN, E. J. A Contribution to the Quantitative Study of Plankton. Ibidem Vol. XII, No. 1.

1928. ALLEN, W. E. Catches of Marine Diatoms and Dinoflagellates taken by boat in Southern California Waters in 1926. Bulletin of the Scripps Institution of Oceanography. La Jolla, California. Technical series. Vol. I, No. 13.

1923. ATKINS, W. R. G. The phosphate content of fresh and salt waters in its relationship to the growth of the algal plankton. Journal of the Marine Biological Association. Vol. XIII.

1926. ATKINS, see POOLE and ATKINS.

1910. APSTEIN, C. Biologische Studie über *Ceratium tripos* var. *subsalsa* Ostenf. Wissenschaftliche Meeresuntersuchungen. N. F. Abt. Kiel, Bd. 10.

1922. BIRGE, EDWARD A. and JUDAY, CHANCEY. The Inland Lakes of Wisconsin. The Plankton. I. Its Quantity and Chemical Composition. Wisconsin Geological and Natural History Survey. Bulletin No. 64, Scientific Series No. 13.

1931. BRAARUD, TRYGVE and FØYN, BIRGITHE. Beiträge zur Kenntnis des Stoffwechsels im Meere. Avhandl. utg. av Det Norske Videnskabs-Akademi i Oslo. I. Matem.-Naturv. Klasse. 1930, No. 14.

1931. BRAARUD, TRYGVE and KLEM, ALF. Hydrographical and Chemical Investigations in the Sea off Møre and in the Romsdalsfjord. Skrifter utgitt av Hvalraadet ved Universitetets Biologiske Laboratorium, Oslo. Nr. 1.

1899. BRANDT, K. Stoffwechsel im Meere. Wissenschaftliche Meeresuntersuchungen. N. F. Abt. Kiel, Bd. IV.

1902. Brandt, K. Der Stoffwechsel im Meere 2. Ibidem, Bd. VI.

1919. Brandt, K. Über den Stoffwechsel im Meere 3. Ibidem, Bd. XVIII.

1932. Burk, Dean, Lineweaver, Hans and Horner, C. Kenneth. 1) Iron in relation to the stimulation of growth by humic acid. 2) The physiological nature of humic acid stimulation of Azotobacter growth. Soil Science, Vol. XXXIII, No. 6.

1927. Gaarder, Torbjørn and Gran, H. H. Investigations of the production of plankton in the Oslo Fjord. Conseil International pour l'Exploration de la Mer. Rapports et Procès-Verbaux Vol. XLII.

1905. Gough, Lewis H. Report on the Plankton of the English Channel in 1903. International Investigations. Marine Biological Association Report I. 1902—03.

1900. Gran, H. H. Diatomaceaé from the Ice and Plankton of the Arctic Ocean. The Norwegian North Polar Expedition 1893—1896. Scientific Results, edited by Fridtjof Nansen, Vol. IV.

1912a. Gran, H. H. The Pelagic Plant Life. The Depths of the Ocean, by Sir John Murray and Johan Hjort.

1912b. Gran, H. H. Preservation of Samples and Quantitative Determination of the Plankton. Publication de Circonstance No. 62.

1915. Gran, H. H. The Plankton Production of the North European Waters in the Spring of 1912. Bulletin Planktonique pour l'année 1912.

1927. Gran, H. H. The Production of Plankton in the Coastal Waters off Bergen March—April 1922. Report on Norwegian Fishery and Marine Investigations Vol. III, No. 8.

1929. Gran, H. H. Quantitative Plankton Investigations carried out during the Expedition with the "Michael Sars", July—Sept. 1924. Rapports et Procès-Verbaux Vol. LVI.

1930. Gran, H. H. The spring growth of the plankton at Møre in 1928—1929 and at Lofoten in 1929 in relation to its limiting factors. Skrifter utgitt av Det Norske Videnskaps-Akademi i Oslo. I. Mat.-Naturv. Klasse 1930, No. 5.

1931. Gran, H. H. On the Conditions for the Production of Plankton in the Sea. Rapports et Procès-Verbaux, Vol. LXXV.

1930. Gran, H. H. and Thompson, T. G. The Diatoms and the physical and chemical conditions of the sea water of the San Juan Archipelago. Publications Puget Sound Biological Station, Vol. 7.

1926. Harvey, H. W. Nitrate in the Sea. Journal of the Marine Biological Association, Vol. XIV.

1928. Harvey, H. W. Biological Chemistry and Physics of Sea Water.

1932. Hentschel, Ernst. Die Biologischen Methoden und das Biologische Beobachtungsmaterial der "Meteor"-Expedition. Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungsschiff "Meteor" 1925—1927. Band X.

1930. Hentschel, Ernst und Wattenberg, Hermann. Plankton und Phosphat in der Oberflächenschicht des Südatlantischen Ozeans. Annalen der Hydrographie, LVIII.

1929. Johnson, Martin W. and Thompson, Thomas G. The Sea Water at the Puget Sound Biological Station from September 1927 to September 1928. Publications Puget Sound Biological Station, Vol. 7.

1905 Karsten, G. Das Phytoplankton des Antarktischen Meeres nach Material der

Deutschen Tiefsee-Expedition 1898—1899. Deutsche Tiefsee-Expedition 1898—1899, Bd. II, 2. Teil.

1930. Kreps, E. and Verjbinskaya, N. Seasonal Changes in the Phosphate and Nitrate Content and in Hydrogen Ion Concentration in the Barents Sea. Journal du Conseil, Vol. V.

1932. Kreps, E. and Verjbinskaya, N. The Consumption of Nutrient Salts in the Barents Sea. Journal du Conseil, Vol. VII.

1908. Lohmann, Hans. Untersuchungen zur Feststellung des vollständigen Gehalts des Meeres an Plankton. Wissenschaftliche Meeresuntersuchungen. N. F. Abt. Kiel, Bd. 10.

1920. Lohmann, Hans. Die Bevölkerung des Ozeans mit Plankton nach den Ergebnissen der Zentrifugenfänge während der Ausreise der "Deutschland" 1911. Archiv für Biontologie, Bd. IV, Heft III.

1928. Marshall, S. M. and Orr, A. P. The Photosynthesis of Diatom Cultures in the Sea. Journal of the Marine Biological Association, Vol. XV.

1928. Moberg, Erik A. The Interrelation between Diatoms, their Chemical Environment, and Upwelling Water in the Sea, off the coast of Southern California. Proceedings of the National Academy of Sciences. Vol. 14, No. 7.

1906. Nathansohn, A. Über die Bedeutung vertikaler Wasserbewegungen für die Produktion des Planktons im Meere. Abh. der Math. Physischen Klasse der Kgl. Sächsischen Ges. der Wissenschaften. Bd. 29, Nr. 5.

1929. Olsen, Carsten. Om Humusstoffernes Indflydelse paa Væksten af grønne Planter i Vandkultur. Meddelelser fra Carlsberg Laboratoriet, Bd. 18, Nr. 1.

1926. Poole, H. H. and Atkins, W. R. G. On the penetration of light into sea water. Journal of the Marine Biological Association, Vol. XIV.

1930. Ruud, Johan T. Nitrates and Phosphates in the Southern Seas. Journal du Conseil, Vol. V.

1931. Savage, R. E. The Relation between the Feeding of the Herring off the East Coast of England and the Plankton of the Surrounding Waters. Ministry of Agriculture and Fisheries. Fishery Investigations, Series II. Vol. XII, No. 3.

1914. Schiller, J. Bericht über Ergebnisse der Nannoplanktonuntersuchungen anlässlich der Kreuzungen der S. M. S. Najade in der Adria. Internationale Revue der gesamten Hydrobiologie und Hydrographie. Bd. 6, Biol. Supplement.

1928. Schreiber, Ernst. Die Reinkultur von marinem Phytoplankton und deren Bedeutung für die Erforschung der Produktionsfähigkeit des Meerwassers. Wissensch. Meeresuntersuchungen, Abt. Helgoland, XVI.

1929. Sund, Oscar. The Determination of Nitrates in Sea Water. Rapport et Procès-Verbaux, Vol. LIII.

1930. Thompson, Thomas G. and Johnson, Martin W. The sea water at the Puget Sound Biological Station from September 1928 to September 1929. Publications Puget Sound Biological Station, Vol. 7, p. 345.

1931. Utermoehl, Hans. Neue Wege in der quantitativen Erfassung des Planktons. Verhandlungen der Internationalen Vereinigung für Limnologie. 5.

1897. Vanhoeffen, E. Die Fauna und Flora Grönlands. Grönlands Expedition der Gesellschaft für Erdkunde zu Berlin 1891—1893. Bd. II.

1932. Waksman, Selman A. and Iyer, K. R. N. Synthesis of a humus-nucleus, an important constituent in soils, peats and composts. Journal of the Washington Academy of Sciences, Vol. 22, No. 3.

1926. Wattenberg, H. Bericht über die chemischen Arbeiten. Die Deutsche Atlantische Expedition auf dem Forschungs- und Vermessungsschiff "Meteor". Zeitschrift der Gesellschaft für Erdkunde zu Berlin. Jahrgang 1926, Nr. 1.

1927. Wattenberg, H. Bericht über die Chemischen Arbeiten. Ibidem. 1927, Nr. 5—6.

1926. Wulff, A. Nannoplanktonuntersuchungen in der Nordsee. Mit Bemerkungen über die Metode des Zentrifugierens. Wissensch. Meeresuntersuchungen, N. F. Abt. Helgoland, Bd. XV.

The Radioactivity of Sea Water.

By

D. Devaputra, Thomas G. Thompson and **Clinton L. Utterback.**

The Chemical and Oceanographic Laboratories of The University of Washington.

Between 1906 and 1917 the radioactive properties of sea water and of the salts of sea water were studied by Strutt (1), Eve (2), Joly (3), Satterly (4), Mialock (5), and Hewlett (6). This property, as measured and computed by these experimenters, varied from zero to 5.4×10^{-11} grams of radium per liter of sea water. Strutt examined one sample. Eve, who examined six samples of water and one of sea salt, found that the warm surface-waters were less radioactive than cold surface-water and that waters taken from near the shore in the Gulf of St. Lawrence were more radioactive than those of the open ocean. Joly studied eleven samples and found that the radioactive properties varied with location, and were greater in waters taken near the land. Satterly examined three samples taken at the high tide at Hunstanton, Dover, and Weymouth. Mialock studied twenty samples of water collected off Uruguay and Chile. Hewlett examined fifteen samples of sea salts from waters which had been collected on the fourth cruise of the "Carnegie". He found these salts to exhibit no radioactivity. It should be mentioned that Hewlett sealed his tubes with paraffin which is known to absorb radioactive gases. The results of these investigators are summarized in Table I.

Table I. Summary of Work of Previous Investigators.

Investigator	Radioactivity in gm. of radium per liter of water $\times 10^{11}$		
	Minimum	Maximum	Average
Strutt	..	..	.23
Eve	.047	.15	.09
Joly	1.15	4.10	2.69
Satterly	.03	.16	.10
Mialock	.29	5.40	2.84
Hewlett	0	0	0

Apparatus and Method.

The apparatus used in the experiments reported below consisted of a Lind gas-tight emanation chamber, a condenser whose rate of discharge could be measured, a special gas burette, and a micro-drying bulb. The method used was the emanation method. This method, and the detailed construction of the apparatus, has been fully described (7).

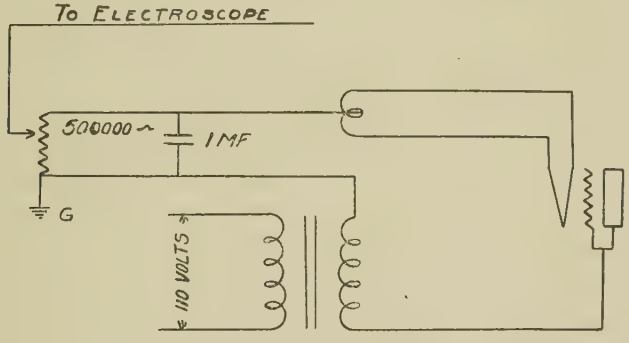


Fig. 1.

The data presented in this paper were obtained by comparing the ionization current obtained in an ionization chamber using the emanation from sea water as an ionizing agent with the current obtained by using the emanation from a standard radium solution as an ionizing agent. The term radioactivity of sea water, as used in this paper, thus represents the ability of the emanation from sea water to produce ionization of the air in the chamber. This ability is numerically determined by expressing the ionization produced by sea water in the equivalent of grams of radium per liter of sea water.

Experimental Procedure.

The ionization chamber was calibrated by measuring the natural rate of discharge, A, of the electroscope when it was connected to the empty chamber. Here, the electroscope was sufficiently charged to deflect the leaf to a suitable scale division. The rate of discharge, B, was then measured when the chamber contained the radon from a known amount of radium. The difference between B and A gave the rate of discharge due to the radon.

The circuit shown in Fig. 1 was used for charging the electroscope. The instrument may be quickly and easily brought to the same potential for each reading. This is much more convenient than other methods of charging.

The radon was introduced into the chamber by the following procedure: Eighty-five ml. of distilled water were placed in 125 ml. pyrex flasks and to each 5 ml. of a standardized radium solution was added. This was equivalent to 1.61×10^{-3} gms. of radium; after adding 10 cc. of concentrated nitric acid the neck of each flask was drawn out to a fine tip, sealed off, as the contents of the flask were vigorously boiled, and allowed to stand for at least one month in order to reach equilibrium. Each flask was then connected to a collecting buret by inserting the tip into a short piece of heavy-walled rubber tubing. The glass tip was then broken, the contents of the flask brought to the boiling point and vigorously boiled until all the emanation was transferred to the ionization chamber. The gases were dried by bubbling slowly through sulfuric acid.

The emanation from sea water was collected in a similar manner to that described above. One liter of sea water was used for each determination. The water was boiled vigorously until all the gases were collected. These were dried, passed into the ionization chamber, and allowed to stand for three hours with the charged electroscope in position on the chamber. At the end of this period the rate of discharge was measured, which with the air discharge rate and the rate found with the radium solution gave at once the radioactivity of the gases in terms of grams of radium per liter of sea water.

In making these measurements, it is necessary to completely remove the active deposits from the chamber before proceeding with a second test. A study has been made of the methods for the rapid removal of these deposits (8).

Sources of Waters.

During the summer of 1930, a great many samples of sea water were examined from the following places: Gulf of Alaska, San Juan Archipelago,

Pacific Ocean off La Jolla, California, North Atlantic Ocean, and Hudson Bay.

In the San Juan Archipelago, eight stations were selected. One, designated as Yellow Island, is in the middle of the San Juan Channel. Samples were taken at the surface, and, at intervals, to a depth of 100

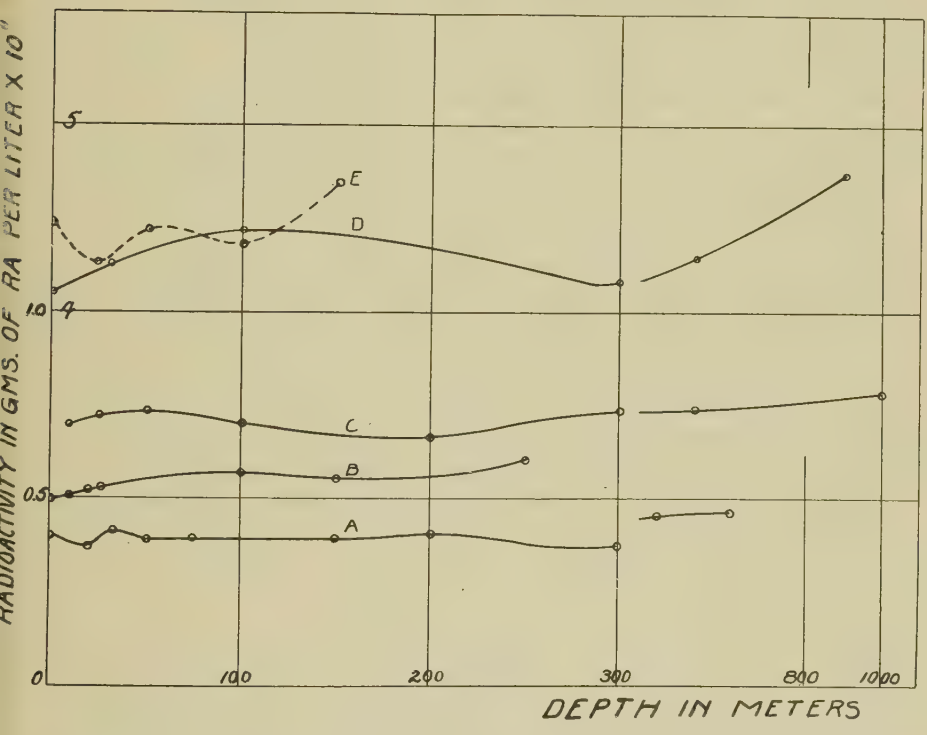


Fig. 2. Variation of Radioactivity with Depth.
Curve A: Off California Coast. — B: San Juan Archipelago. — C: Gulf of Alaska. D: North Atlantic. — E: Hudson Bay.

meters on July 6 on an incoming tide and on August 2 on an outgoing tide. Very strong tidal currents occur in the channel so there is considerable mixing of waters from different localities. The radioactivity, in general, increased with depth.

The second station, designated as Spieden Island, was located at the entrance to President Channel and San Juan Channel. The samples were taken on the same days and with the same tidal conditions as above. There was an increase in radioactivity with depth.

The third station was in Haro Straits. The water here was quite turbulent and some irregularity of radioactivity with depth was observed.

Samples were taken at a fourth station in Argyle Lagoon. This is a very shallow lagoon from which the water continues to run for some time after the tide has started to flood in the outer bay (9). The samples were taken here on July 11 and July 28 on extremely low tides.

The fifth, sixth, and seventh stations were selected in East Sound, a narrow sound about seven miles long. One station was at the mouth, one 3.5 miles from the mouth, and one at the extreme end of the Sound. These stations are designated, in order, as Olga, Rosario, and East Sound. The samples were taken here on an incoming tide of July 7 and August 3.

The eighth station was located in the channel between Browns Island and San Juan Island. Samples of surface water were taken August 20 every three hours for a 24-hour period. The difference in tide on this day was 9.8 feet. But little change was indicated during this tidal cycle, the large flood tide showing slightly more radioactivity than the great ebb.

The results obtained from the first seven of these stations are given in Table II, and those from the eighth station are given in Table III.

Fig. 2 shows the variation in radioactivity with depth of water from the several regions studied. The curve for the San Juan Archipelago is drawn from data obtained by averaging the results of each depth from which samples were taken. The other curves of Fig. 2 are plotted from the data of Table V.

Conclusions.

A summary of the results of this preliminary study is obtained from the curves of Fig. 2 in which the radioactivity of the waters is plotted against depth. These curves present several relations. Curves A, B, and C show that the radioactivity of the Pacific water has a minimum value. For the Gulf of Alaska and the San Juan Archipelago, this minimum occurs at a depth of 200 meters. The minimum for the California waters is at a depth of 300 meters. At greater depths the radioactivity of all these waters shows a decided increase.

It is to be noted that the radioactivity of the waters of the Pacific shows an increase as one proceeds from south to north. For example, the radioactivity of the surface waters as given in curves A, B, and C stands in the ratio of 1:1.25:1.75. It was noticed by Eve (2) that warm waters were less active than cooler waters.

Table II. The radioactivity of the waters of the San Juan Archipelago.

Station	Depth in Meters	Temp. °C.	Chlorinity ‰	Radioactivity gms. Ra per liter × 10^{11}	Temp. °C.	Chlorinity ‰	Radioactivity gms. Ra per liter × 10^{11}
		July 6, 1930			August 2, 1930		
Yellow Island	0	10.00	16.80	0.39	10.60	16.96	0.47
	10	9.95	16.80	0.50	10.40	16.96	0.39
	25	9.90	16.84	0.58	10.37	16.96	0.42
	50	9.80	16.90	0.50	10.35	16.91	0.50
	100	9.60	17.12	0.64	10.00	17.06	0.56
Spieden Island	0	10.20	16.69	0.47	10.15	17.00	0.55
	10	9.90	16.80	0.46	10.10	16.96	0.51
	25	9.90	16.80	0.49	10.10	17.01	0.51
	75	9.70	16.91	0.54	10.10	17.01	0.47
	150	9.40	17.17	0.62	10.05	17.06	0.48
Haro Strait	0	9.95	16.96	0.58	10.80	16.88	0.46
	10	9.90	16.91	0.55	10.40	17.01	0.48
	25	9.60	17.12	0.58	10.00	17.21	0.46
	50	9.25	17.19	0.35	9.70	17.38	0.52
	100	9.15	17.27	0.38	9.45	17.49	0.56
	250	8.20	18.06	0.56	8.60	17.90	0.69
		July 11, 1930			July 28, 1930		
Argyle Lagoon	0	..	17.06	0.51	..	16.85	0.44
		July 7, 1930			August 3, 1930		
Olga	0	..	..	..	13.65	16.75	0.63
	5	..	..	..	11.30	16.64	0.53
	10	..	..	..	11.30	17.80	0.65
	15	..	..	..	11.20	17.80	0.62
	20	..	..	..	9.90	17.91	0.52
Rosario	0	..	..	..	15.70	16.64	0.40
	5	..	..	..	11.45	16.69	0.40
	10	..	..	..	11.15	16.75	0.48
	15	10.35	16.85	0.48	11.05	16.75	0.41
	20	10.20	16.85	0.56	11.00	16.82	0.63
East Sound	0	15.20	16.58	0.30	15.75	16.64	0.39
	5	13.65	16.58	0.35	11.65	16.64	0.33
	10	10.40	16.85	0.41	11.20	16.69	0.35
	15	10.50	16.81	0.50	11.05	16.75	0.47
	20	10.50	16.64	0.35	11.00	16.75	0.46

Table III. The Radioactivity During a Tidal Cycle in the San Juan Archipelago.

	Time of Sampling	Temperature °C.	Tide	Chlorinity ‰	Radioactivity in grams of radium per liter × 10^{11}
A. M.					
	2:15	12.2	Great Ebb	16.17	0.60
	5:15	12.5	Great Ebb	16.23	0.63
	8:15	12.5	Great Flood	16.33	0.63
	11:15	13.9	Great Flood	15.79	0.64
P. M.					
	2:15	13.6	Great Flood	16.17	0.62
	5:55	13.6	Small Ebb	16.23	0.62
	8:15	12.0	Small Flood	16.71	0.62
	11:15	11.9	Great Ebb	16.66	0.58

In Table IV are given the averages of the data obtained at all of the stations in the San Juan Archipelago. These averages are used for comparison with data obtained from waters collected from other regions of the world.

Table IV. Averages of All Stations in San Juan Archipelago.

Depth	Number of Samples	Radioactivity in grams of radium per liter × 10^{11}
0	13	0.49
10	8	0.50
20	5	0.52
25	6	0.53
100	4	0.57
150	2	0.55
250	1	0.60

The results of the examination of the waters from other parts of the world are shown in Table V. In all cases, the lapse of time between collecting and analyzing the waters was approximately the same.

While the average results of all the stations in the San Juan Archipelago are given in Curve B, an examination of the results of each station shows that the waters collected in August were less active than those collected in July. The temperature of the waters collected in July was lower than that of waters collected in August. Also, a slight variation in radioactivity with the tides is noticed. In general, the waters of a great flood tide are more radioactive than those of the following ebb tide.

The waters of the North Atlantic and of Hudson Bay show much greater radioactivity than any of the Pacific waters. Also, the radioactivity

Table V. Radioactivity of Ocean Waters Collected From Different Regions.

Station	Date	Depth in meters	Temp. °C.	Clorinity ‰	Radioactivity in grams of radium per liter × 10^{11}
Gulf of Alaska	April	10	4.00	18.13	0.70
56° 24′ N. Lat.	1930	25	4.00	18.14	0.72
144° 04′ W. Long.		50	4.00	18.14	0.73
		100	3.70	18.17	0.70
		200	2.92	18.31	0.66
		300	0.37	18.36	0.74
		500	0.75	18.53	0.74
		1000	1.55	18.59	0.77
Off California Coast	June	0	..	18.60	0.40
32° 52′ N. Lat.	1930	20	..	18.61	0.37
117° 21′ W. Long.		30	..	18.58	0.41
		50	..	18.57	0.39
		75	..	18.75	0.39
		150	..	18.92	0.39
		200	..	18.95	0.41
		300	..	18.99	0.37
		400	..	19.01	0.46
		600	..	18.54	0.46
North Atlantic	June	0	17.89	18.49	4.06
38° 08′ N. Lat.	1930	60	11.10	19.06	4.24
73° 27′ W. Long.		100	11.32	19.34	4.43
		300	11.74	19.40	4.17
		600	11.05	19.33	4.38
		900	4.65	19.34	4.74
Hudson Bay	August	0	9.45	16.36	4.47
57° 58′ N. Lat.	1930	25	—1.14	17.48	4.22
86° 54′ W. Long.		50	—1.86	17.69	4.44
		100	—1.94	17.91	4.35
		150	—1.93	17.99	4.70
Hudson Bay	August	0	8.50	16.11	4.74
61° 11′ N. Lat.	1930	25	—1.34	17.56	3.82
90° 0′ W. Long.		50	—1.95	17.67	4.21
		75	..	17.71	3.95
		100	—1.97	18.04	4.51

of the Hudson Bay waters is, in general, greater than that of those of the North Atlantic at similar depths.

In the case of the North Atlantic water a minimum value of the radioactivity is reached at a depth of 300 meters, while in the case of the Hudson

Bay waters, curve E shows two minima. The first of these occurs at about 20 meters, and the second one at 100 meters. Curve A shows a similar variation in the radioactivity near the surface. The values of the radioactivity of the Atlantic waters are of the same order of magnitude as the values reported by MIALOCK and JOLY, but are considerably greater than the values reported by other observers. Within our knowledge there is no data for the radioactivity of the waters of the Pacific except that recorded by MIALOCK for the South Pacific.

The authors realize that data bearing on the radioactivity of sea waters are meager and what is available shows much to be desired in the way of confirmatory values. A much more extensive survey of this property is now being made.

The radioactive properties of sea water appear to be independent of the chlorinity.

Aknowledgment.

It is with pleasure that acknowledgement is made of the cooperation of Dr. E. G. MOBERG of Scripps Institution of Oceanography and Mr. RICHARD VAN CLEVE and Professor W. F. THOMPSON of the International Fisheries Commission in collecting some of the samples from regions of the Pacific. Through the kindness of Dr. H. B. BIGELOW, the waters from the North Atlantic were collected by the United States Bureau of Fisheries, and those from the Hudson Bay were collected by an expedition of the Biological Board of Canada with the cooperation of Dr. A. C. HUNTSMAN and Mr. H. B. HACHEY.

Bibliography.

1. STRUTT, R. J. Proc. Roy. Soc. A, **78**, 150 (1906).
2. EVE, A. S., Phil. Mag. (**6**), **13**, 248 (1907); (6), **18**, 102 (1909).
3. JOLY, J., Phil. Mag. (6), **15**, 385 (1908).
4. SATTERLY, J., Proc. Camb. Phil. Soc. **16**, 360 (1911).
5. MIALOCK, U., Anales Soc. Cientifica Argentine **79**, 267, (1915).
6. HEWLETT, C. W., Terrestrial Magnetism and Atmospheric Electricity. **22**, 175 (1917).
7. Central Scientific Company. Bulletin No. 176.
8. UTTERBACK, C. L. and DEVAPUTRA, D. The Review of Scientific Instruments (2), **1**, 53—54 (1931).
9. BLALOCK, P. and THOMPSON, T. G., Pub. Puget Sound Biol. Station **5**, 341—354 (1927).

The Susceptibility of Cod Eggs to external Influences.

By

Gunnar Rollefsen.

Norwegian Bureau of Fisheries, Bergen.

A brief account of the way in which cod eggs are killed when exposed to such influences as shock and shaking has been given earlier (1). It was shown that the thin layer of protoplasm covering the yolk was the principal element subject to destruction, thus allowing the yolk to escape and mix with the fluid of the perivitteline space. My work with cod eggs was continued in 1930; the results will be published in full at a later date, and in the meantime the following summary is offered for the convenience of other workers.

As the cod eggs were destroyed by external influences it was considered interesting to find out what degrees of such influences were necessary to kill them. The cod eggs were accordingly caused to drop from different heights. A piece of silk was strained on a cylindrical frame of celluloid and a glass cylinder (50 cm. high and 7 cm. wide) was fastened to a stand, while the lower end of the cylinder rested on the silk (fig. I). The eggs were dropped down on to the silk by means of a pipette kept inside the glass cylinder. The opening of the pipette allowed 20—30 eggs to fall in each drop. The effect of the fall could be modified by keeping the pipette at different distances from the silk.

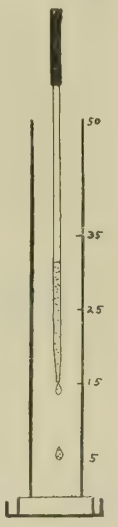


Fig. I.

The advantages of this method were that the eggs were simultaneously exposed to the same effect and the risk of losing eggs during the experiment was very small. After the fall the eggs were transferred into small glass dishes containing sea water (by turning the frame upside down). The examination of the eggs followed after 6—18 hours. The dead eggs lying at the bottom and the living ones floating were counted and the proportion between the number of dead eggs and the whole number of eggs used was taken as a measure of the effect.

Before giving the results of the present investigation it might be convenient to recall certain features of the cod egg and its development. The egg is surrounded by an egg membrane (*zona radiata*), hyaline but rather tough (fig. II). The egg proper is separated from the egg membrane

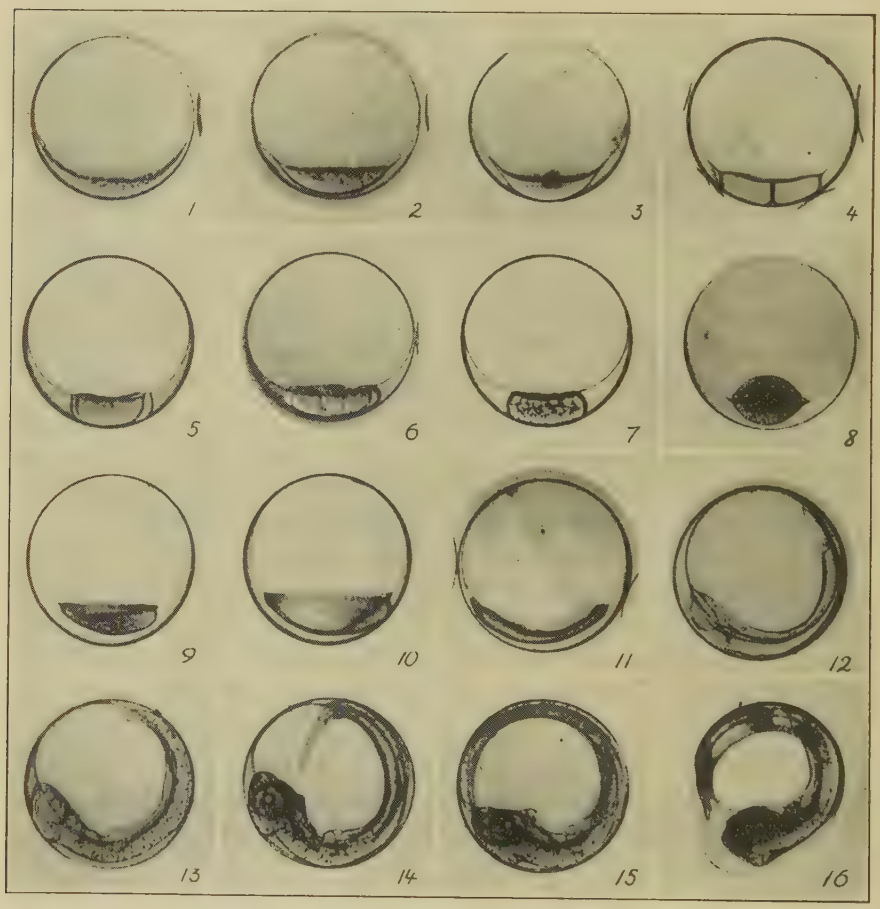


Fig. II. The development of the cod egg.

by the fluid of the perivitteline space. The main bulk is the yolk. The active protoplasm is concentrated as the blastodisc at the lower pole of the yolk-globule, but it also spreads over the entire surface of the yolk as a thin film (fig. II, 1—8). During gastrulation the blastodisc flattens and spreads over the yolk, which is thus gradually covered by the tissue of the embryo (fig. II, 9—12). At last the yolk is fully enveloped and the blastopore closed up (fig. II, 13—16 and fig. III).

According to this we can separate two periods in the development, the first in which the yolk is covered only by the thin layer of protoplasm, the second in which the yolk is enveloped by a layer of embryonal tissue.

The material for the experiments was gathered with a net in the Westfjord or (for the greater part) procured by artificial fertilization. The

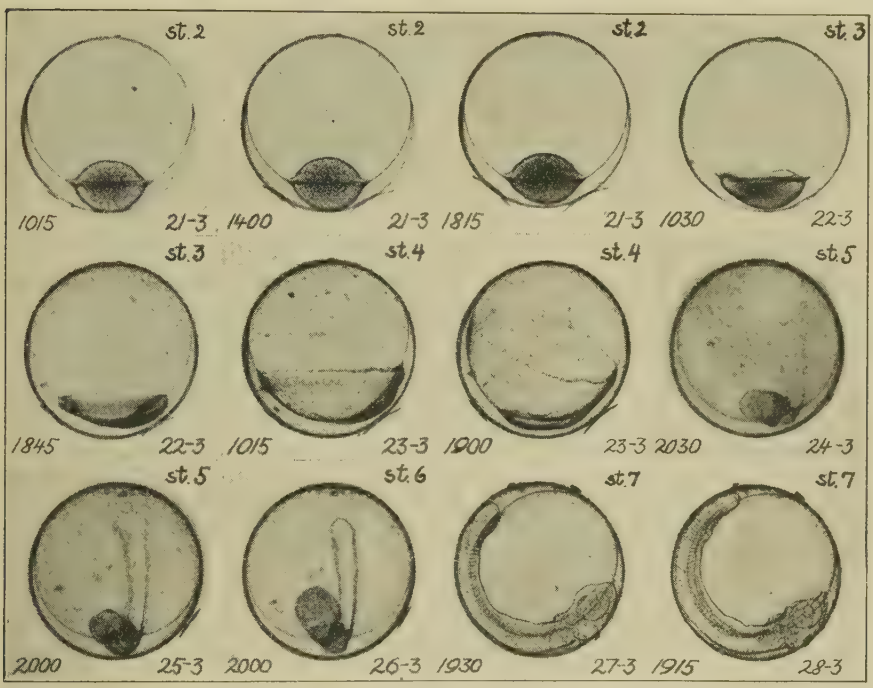


Fig. III. The gastrulation of the cod egg. Stage 2 to 7. The figures below refer to time and date.

whole development of the cod egg was, with regard to these experiments, divided into 12 stages of approximately equal duration (at constant temperature). Egg lots of all these 12 stages of development were dropped from 5, 15, 25, 35 and 50 cm. heights. A number of eggs not exposed to falls served as control (C_1).

As control of a possible effect of the manipulation necessitated by the dropping experiments a number of eggs not exposed to falls but handled like the others was taken out (C_2).

The results of the experiments are tabulated below:

Table I.

Number of eggs used in each experiment.

Stage	Controls		Heights of fall (cm.)				
	C_1	C_2	5	15	25	35	50
1	1306	3220	3238	3433	3506	3321	2759
2	2183	2627	3354	3407	3253	3690	2279
3	1617	1800	3609	4130	3339	4081	1790
4	538	508	2065	2558	1754	2218	1004
5	1032	875	4084	5354	4822	4709	3735
6	512	445	407	995	1243	773	666
7	647	532	552	671	728	845	790
8	220	175	561	447	476	443	434

Table II.

Percentage of eggs killed in each experiment

Controls		Heights of fall (cm.)				
C_1	C_2	5	15	25	35	50
5	4	5	30	53	69	79
7	5	3	31	56	72	82
10	7	7	44	69	82	87
3	6	5	40	65	78	86
5	8	4	25	45	60	70
3	3	4	6	14	20	30
1	2	3	5	6	13	17
3	0	3	5	4	8	13

The two control series show in stage 1 a death-rate of 5 and 4 per cent. Falling from 5 cm. the eggs seem not to be injured perceptibly, while a fall at 15 cm. causes death to 30 % of the eggs, and a drop of 50 cm. 79 deaths per hundred. The susceptibility is found to increase up to the 3rd stage. Then it decreases into the 6th and afterwards remains low. Fig. IV gives the curves for the susceptibility of the eggs during development.

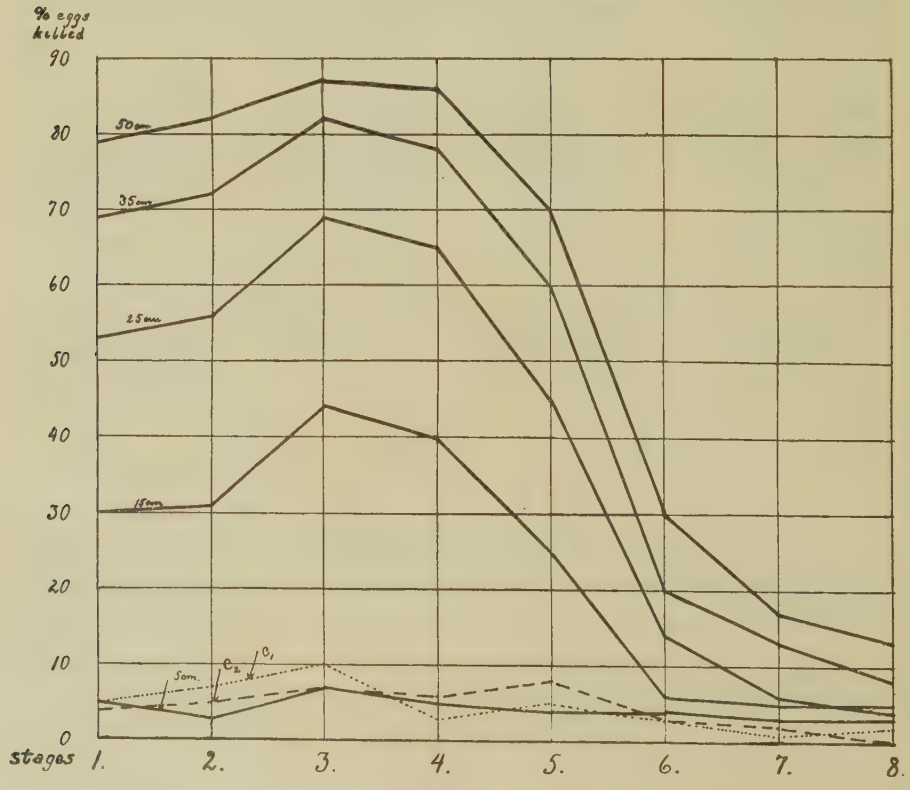


Fig. IV.

As mentioned above the thin layer of protoplasm bursts when the eggs are exposed to shaking and shock and the same is the case when they are dropped, but the outer egg membrane, however, withstands all this rough handling.

From stage 1 to 3, the major part of the yolk is covered by this thin original layer but during stages 4 and 5 the yolk gets its new covering of embryonal tissue, and in stage 6 it is completely enveloped (fig. III).

The sensitive condition is thus characterised by the egg being only covered by the thin protoplasmic film, the resistant condition by a covering of embryonal tissue, the quick growth of the blastodisc over the yolk being accompanied by a rapid decrease of the susceptibility. We may therefore be justified in ascribing the increased resistance of the egg to the covering up of the yolk by embryonal tissue.

The susceptibility of fish eggs to external influences has been investigated by Walter Hein (2), Kyuzo Hata (3) and Scheminzky (4) with partners, using salmon and trout eggs, i. e. eggs of the demersal type. Hein exposed the eggs to shocks, Hata exposed them to vibrations and Scheminsky to electric currents.

They all found the susceptibility of the eggs changing during the incubation and in the same manner as just described for the cod eggs, the young eggs being more sensitive than the old ones. Hein and Hata explain neither the sensitivity nor the cause of its alteration. But the interpretation of the susceptibility and its variation put forward by Scheminsky differs a good deal from that given above for the cod eggs.

He found they were killed by an electric current, the eggs becoming opaque owing to the precipitation of the proteins of the yolk in contact with water. He explains this as a consequence of permeability of the *egg membrane* caused by the electric current.

Now the egg membrane of the cod egg is always permeable and allows salt and dyes (like methylene blue) to enter the perivitteline fluid. The protoplasm layer of the yolk is, however, impermeable. But when this layer is destroyed the yolk will mix with the perivitteline fluid and this mixture with the yolk (which is of low salt content) reduces the salinity inside the egg membrane. Through this, however, salt enters, causing the egg to sink. A normal cod egg put into *fresh* water will remain transparent, but as soon as the yolk breaks through its enveloping film it will become opaque.

Scheminzky like Hein and Hata found the sensitive period lasting from the 1st to the 15th day of development, when resistance was established. Scheminzky now seeks the cause of this variation in chemical events: "Die Veränderung ist eine Folge der Entwicklung und nicht des

Alters und hängt mit den chemischen Vorgängen während der Embryogenese zusammen". Comparing the curves of susceptibility given by Hein, Hata and Scheminzky with the development stages of the trout afforded by Kopsch (5) the similarity to the cod eggs is evident (fig. V). The sensitive condition is observed in the period when the yolk is covered by the protoplasm layer only, and resistance begins when the yolk is covered by embryonal tissue.

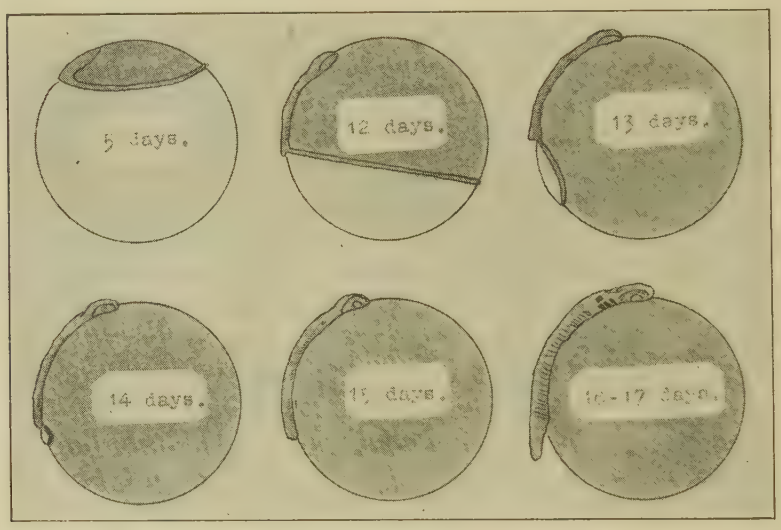


Fig. V. The egg of the trout. After Fr. Kopsch.

Scheminzky and Gauster (4) do not mention the covering layer of protoplasm in connection with the reactions of the eggs to electric currents; they only speak of the egg membrane. Nor is the gastrulation mentioned in connection with the changes in sensitivity. Assuming, as in the case of cod eggs, that the original covering of the yolk is the element injured, no difficulties arise in explaining the effects of electric currents. And the change of susceptibility during the development becomes a very natural explanation.

Bibliography.

1) Rollefsen, Gunnar. Observations on Cod eggs. Rapport et Procès-Verbaux, Vol. LXV, 1930.

2) Hein, Walter. II. Zur Biologie der Forellenbrut.

2) Über die absolute Druckfestigkeit der Bachforelleneier.

3) Über die Wirkungen von Druck, Stoss und Fall auf die Entwicklung der Bachforelleneier. Allgemeine Fischereizeitung, 1907.

Hein, Walter. III. Über die Wirkungen plötzlicher Temperaturschwankungen auf die Eier und Brut von Bachforellen. Allgemeine Fischereizeitung, 1911.

3) Hata, Kyuzo. On the influence of four kinds of vibration upon the eggs of *Onchorhynchus masou* Brevoort. Journal of the Imperial Fisheries Institute, vol. XXIII, no. 3. Tokyo, 1927.

4) Scheminzky, Ferd. Über die verschiedene Empfindlichkeit der Forelleneier während ihrer Entwicklung dem elektrischen Strom gegenüber. Biochemische Zeitschrift, B. 132, Heft 1/3, 1922.

Scheminzky, Ferd. und Fritzi Gauster. Beiträge zur physikalisch-chemischen Biologie der Forellenentwicklung. 1. Mitteilung: Die Schädigung der Membran des Forelleneies durch den elektrischen Strom. Archiv für mikroskopische Anatomie und Entwicklungsmechanik. B. 101, Heft 1/3, 1924.

Kronfeld, Peter und Ferdinand Scheminzky. Beiträge zur physikalisch-chemischen Biologie der Forellenentwicklung. 2) Mitteilung: Wachstum, Dotterresorption und Wasserhaushalt. Archiv für Entwicklungsmechanik der Organismen. B. 107, 1926.

5) Kopsch, Fr. Die Entwicklung der äusseren Form des Forellenembryo. Archiv für mikroskopische Anatomie und Entwicklungsgeschichte. B. 51, Bonn, 1898.

Unsicherheiten bei Bestimmung der Wirbelzahl infolge Verwachsungserscheinungen.

Von

Dr. **Rudolf Kändler,** Hamburg.

(Deutsche wissenschaftliche Kommission f. Meeresforschung).

Das Achsenskelett eines Fisches gliedert sich normalerweise in eine Anzahl wohlgesonderter Wirbel. Gelegentlich kommen jedoch infolge Entwicklungsstörungen Verwachsungen von zwei und mehr Wirbeln vor. Hierbei sind in der Regel die Neural- und Hämalbögen und auch die Spinalfortsätze — wenigstens einseitig — in einer der Anzahl der Wirbelelemente entsprechenden Zahl ausgebildet, während die Wirbelkörper zu einem Stück verschmolzen sind, an dem die Zusammensetzung aus mehreren Teilen noch mehr oder weniger deutlich zu erkennen ist. Solchen Abnormitäten der Wirbelsäule von *Clupea harengus* haben Ford und Bull[1]), später Schnakenbeck[2]) besondere Aufmerksamkeit

[1]) E. Ford and H. O. Bull: Abnormal vertebrae in herrings. Journ. Mar. Biol. Assoc. Plymouth. XIV, 2, 1926.

[2]) W. Schnakenbeck: Entwicklungsgeschichtliche und morphologische Untersuchungen am Hering. Ber. D. W. K., N. F. V, 2, 1929.

zugewandt. Die beiden erstgenannten Forscher fanden unter 6869 Heringen von Plymouth 105 Exemplare mit Wirbelverwachsungen, d. s. 0,65 %. Ihre Häufigkeit ist also bei dieser Art recht gering. Bei der Ermittlung der Frequenzen der Wirbelzahlen ist es deshalb praktisch gleichgültig, ob man diese wenigen Tiere als abnorm ausschliesst oder mit berücksichtigt. Jene 105 Heringe ergaben aber nur dann den gleichen Mittelwert für Vert. S. wie die übrigen normalen Individuen, wenn jeder Bestandteil der Verwachsungen gesondert gezählt wurde. Daraus ergibt sich die Forderung, die bereits Fr. Heincke[1]) erhebt, dass bei Berücksichtigung von Individuen mit Wirbelverwachsungen die einzelnen Komponenten zu zählen sind. Über das Vorkommen verschmolzener Wirbel bei anderen Fischen finden sich in der Literatur nur vereinzelte Angaben, so bei G. Duncker[2]) über *Pleuronectes platessa*, bei Johs. Schmidt[3]) über *Gadus morrhua*. Sie sind wohl eine allgemeine Erscheinung; ich fand sie ausser bei den genannten Arten noch bei *Pleuronectes flesus*, *Pleuronectes limanda*, *Rhombus maximus* und *Clupea sprattus*. Diese Missbildungen sind in der Ostsee, namentlich in ihrem östlichen Teil, bei gewissen Arten ziemlich häufig. Besonders stark ist die Scholle davon betroffen. Während ich unter 100 Exemplaren aus der südöstlichen Nordsee kein Tier mit Wirbelverwachsungen fand, traten solche in der westlichen Ostsee (Travemünde) mit 3 % auf, in der östlichen Ostsee (Oderbank) sogar mit 19 %. Dieser ausserordentlich hohe Prozentsatz gerade in einem Gebiet, das sich an der Verbreitungsgrenze der Art befindet, legt die Vermutung nahe, dass ungünstige Lebensbedingungen die Ursache ihrer Entstehung sind. Die Verschmelzung der Wirbel erfolgt wohl in vielen Fällen bereits bei ihrer Anlage; es ist jedoch wahrscheinlich, dass auch normal ausgebildete Wirbel nachträglich miteinander verwachsen können. Wirbelverwachsungen bei der Flunder sind ebenfalls nicht selten: Unterelbe 3 %, westliche Ostsee 3,5 %, Oderbank 4 %, Danziger Bucht 6 %. Auch hier zeigt sich in der östlichen Ostsee eine wenn auch geringe Zunahme. Beim Steinbutt aus der westlichen Ostsee (Warnemünde) und bei der Kliesche aus dem Gebiet östlich von Rügen betrug der Anteil der abnormen Individuen 5 %. Vergleichszahlen aus anderen Gebieten fehlen noch. Auch beim Dorsch ist eine Zunahme in der Ostsee vom Westen nach dem Osten festzustellen; genauere Unterlagen für diese Art und für den Sprott

[1]) Fr. Heincke: Naturgeschichte des Herings, S. 97. Abhandl. Dtsch. Seefisch.-Ver. II, 1898.

[2]) G. Duncker: Variation und Verwandtschaft von *Pl. flesus* und *Pl. platessa*. Wiss. Meeresunt. N. F. Abt. Kiel. I, 1896.

[3]) Johs. Schmidt: Racial investigations. X. The Atlantic cod and local races of the same. C.-R. d. trav. Lab. Carlsberg, XVIII, Nr. 6. 1930.

stehen noch aus. Es ist wünschenswert, dass man diesen Abnormitäten, da sie bei einzelnen Arten in der Ostsee so häufig sind, erhöhte Aufmerksamkeit schenkt. Sie tragen in diesem Falle mit zur Charakterisierung der Art in einem Meeresgebiet bei.

Die bisher besprochenen Wirbelverschmelzungen können grundsätzlich jeden Wirbel betreffen, wenn auch bestimmte Abschnitte der Wirbelsäule dabei bevorzugt werden, wie Ford und Bull für den Hering nachwiesen. Bei der Scholle neigen besonders die Schwanzwirbel zu Verwachsungen, die Rumpfwirbel in geringerem Masse.

Wesentlich anders liegen die Verhältnisse bei Verwachsungserscheinungen, welche sich an den Enden der Wirbelsäule von Plattfischen finden. Ich wurde auf diese Bildungen dadurch aufmerksam, dass im Rumpfabschnitt die Zahl der dorsalen Dornfortsätze gelegentlich um 1 grösser ist als die Zahl der zugehörigen Wirbel. In solchen Fällen trägt der erste Wirbel zwei Dornfortsätze. Der Wirbelkörper selbst ist etwas länger als normalerweise und als der des folgenden Wirbels, zeigt aber in der Regel keinerlei Verwachsungsspuren. Seiner Form nach gehört der 2. Dornfortsatz zum Wirbelkörper, während der 1. als »akzessorisch« bezeichnet werden muss. Er ist schwächer ausgebildet, und der Neuralbogen, auf dem er sitzt, ist im unteren Teil mit dem Bogen des folgenden Fortsatzes verwachsen (Fig. 1). Lediglich zwei von insgesamt 46 beobachteten derartigen Wirbeln lassen am Wirbelkörper erkennen, dass zwei ursprünglich gesonderte Wirbel später miteinander verwachsen sind.

Fig. 1. Pleuronectes platessa (Oderbank). Länge 8 cm. 1.—3. Wirbel

Einmal auf diese akzessorischen Spinalfortsätze aufmerksam gemacht, untersuchte ich auch den vor dem Urostyl liegenden Schwanzwirbel eingehend, der mir bereits öfters durch seine relativ grosse Länge aufgefallen war. Auch dieser, nach der üblichen Zählweise als vorletzter bezeichnete Wirbel trägt gelegentlich an einer Seite oder an beiden Seiten zwei Dornfortsätze, die einem einheitlichen oder doppelt ausgebildeten oberen bezw. unteren Bogen aufsitzen (Fig. 2 und 3). In den weitaus meisten Fällen ist der Wirbelkörper durchaus einheitlich. Bei sorgfältiger Durchmusterung einer grösseren Zahl konnte ich jedoch Individuen finden, bei denen dieser Wirbel eine deutliche Verwachsungsleiste besitzt und die Bogen und Fortsätze beiderseits paarig vorhanden sind. Er bietet dann das gleiche Bild wie die verschmolzenen Wirbel, die im

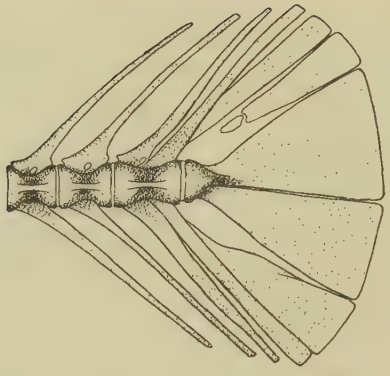


Fig. 2. Pleuronectes platessa (Oderbank). Länge 8 cm. 40.—43. Wirbel.

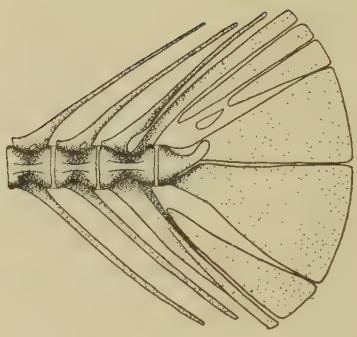


Fig. 3. Pleuronectes platessa (südöstl. Nordsee). Länge 5 cm. 40.—43. Wirbel.

übrigen Bereich der Wirbelsäule vorkommen. In einem Falle trägt der vorletzte Wirbel bei gut erkennbarer Verwachsungsnaht an einer Seite nur einen Dornfortsatz, der mittels eines sehr breiten Bogens den beiden verschmolzenen Wirbelkörpern aufsitzt.

Man kann der Meinung sein, dass es sich bei diesen Bildungen an den beiden Enden der Wirbelsäule um grundsätzlich die gleichen Verwachsungserscheinungen handelt, wie sie auch im übrigen Bereich der Wirbelsäule auftreten. Eine Sonderstellung nehmen sie jedoch insofern ein, als in der Regel die Verschmelzung der Wirbelkörper vollkommen ist und nur noch am Vorhandensein überzähliger Spinalfortsätze erkannt werden kann. Ihre Entstehung muss also sehr frühzeitig erfolgen, und tatsächlich lässt sie sich bereits an Larven feststellen, bei denen die Wirbelanlagen infolge der beginnenden Verknöcherung durch Färbung mit Alizarin sichtbar gemacht werden können. Die beigegebenen Abbildungen einer Klieschenlarve und eines jüngsten Bodenstadiums der Flunder (Fig. 4

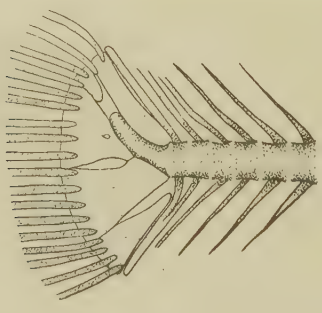


Fig. 4. Pleuronectes limanda (Ostküste v. Schottland). Larve von 12 mm Länge. 35.—40. Wirbel. (Präparat von Dr. Schnakenbeck).

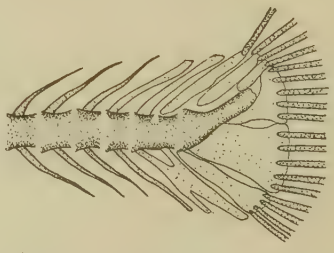


Fig. 5. Pleuronectes flesus (Unterelbe). Jüngstes Bodenstadium von 9 mm Länge. 29.—34. Wirbel.

und 5) lassen folgendes erkennen. Der vor dem Urostyl liegende perichordale Knochenring ist doppelt so breit wie der vorhergehende, entspricht also vermutlich zwei Segmenten, zwischen denen auch der intervertebrale Raum bis auf eine kleine, dorsal gelegene Lücke zu verknöchern beginnt. Dorsal schliessen die Anlagen zweier Neuralbögen und Dornfortsätze an; ventral sind nur die Hämalbögen paarig angelegt, sie vereinigen sich dann zu einem einheitlichen Fortsatz, der bei der abgebildeten Flundernlarve sich am Ende wieder aufspaltet. Die Weiterentwicklung einer solchen doppelten Anlage zu einem Gebilde, wie es etwa in Fig. 3 von einer 5 cm grossen Nordsee-Scholle dargestellt ist, ist ohne Schwierigkeiten verständlich. Der bereits in der Anlage nahezu einheitliche Wirbelkörper gestaltet sich wie eine Einheit, auch die Hämalbögen verwachsen miteinander, und die Doppelnatur dieses »komplexen Wirbels«, wie ich ihn nennen möchte, ist nur noch an seiner den vorhergehenden etwa um ein Drittel übertreffenden Länge und an den paarig vorhandenen Neuralbögen und oberen Dornfortsätzen zu erkennen. Das völlige Fehlen jeder Verwachsungsspur am Wirbelkörper erklärt, dass diese Bildungen bisher übersehen worden sind.

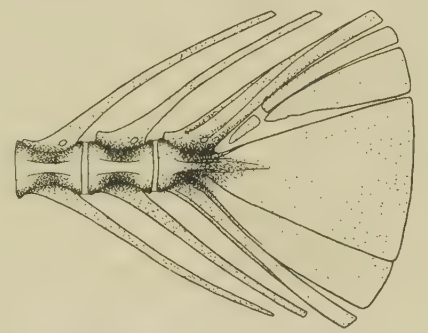


Fig. 6. Pleuronectes platessa (Oderbank). Länge 11 cm. 41.—43. Wirbel.

Gelegentlich kann auch das Urostyl obere und untere Bögen und Dornfortsätze tragen (Fig. 6). Dabei ist zuweilen die Zahl der Epuralia und Hypuralia reduziert; stets sind das letzte Epurale und das letzte Hypurale miteinander zu einer einheitlichen Knochenplatte verwachsen. Diese Bildung ist zurückzuführen auf eine Verschmelzung des Urostyls mit dem ursprünglich vorletzten Wirbel, was in einzelnen Fällen auch an einer Verwachsungsleiste am Wirbelkörper zu erkennen ist. Bei einer Ostsee-Kliesche sind sogar beide Anomalien am Schwanz kombiniert; der aus zwei Teilen bestehende Körper des Urostyls trägt jederseits 3 Dornfortsätze.

Es ist in der Literatur nur ein Fall beschrieben, der Ähnlichkeit mit den hier besprochenen Wirbelverschmelzungen hat. Johs. Schmidt[1]) fand bei der Kreuzung von *Salmo trutta* mit verschiedenen Wirbelzahlen unter

[1]) Johs. Schmidt: Racial investigations. VIII. The numerical signification of fused vertebrae. C.-R. d. trav. Lab. Carlsberg, XIV, Nr. 16. 1921.

den Abkömmlingen Exemplare, deren 5. Wirbel, vom Schwanzende aus gezählt, Besonderheiten zeigte. Die Anlage des Wirbelkörpers der etwa 2 cm grossen Fischchen war länger als gewöhnlich, und Neural- und Hämalbögen waren doppelt, letzterer nur in seinem proximalen Teil. Diese Bildung wurde bei 10 % der Individuen immer an dem gleichen Wirbel beobachtet.

Der Unterschied zwischen »echten Verwachsungen«, die auch am Wirbelkörper Spuren hinterlassen, und den komplexen Wirbeln, die solche nicht besitzen, ist zunächst nur ein morphologischer. Man darf jedoch vermuten, dass sich beide Bildungen auch genetisch unterscheiden durch ihre Ursachen und durch den Zeitpunkt, an dem die Verschmelzung der beiden Komponenten stattfindet. Bei den echten Verwachsungen, die offensichtlich Missbildungen sind, handelt es sich wahrscheinlich um die nachträgliche Vereinigung zweier ursprünglich gesonderter Wirbelanlagen bezw. mehr oder weniger ausgebildeter Wirbel. Das regelmässige Vorkommen der komplexen Wirbel spricht dagegen, dass sie ebenfalls krankhafte Missbildungen darstellen. Die in Fig. 4 und 5 wiedergegebenen Schwanzabschnitte von Larven legen die Vermutung nahe, dass die unvollständige Trennung zweier Wirbelanlagen zur Entstehung eines komplexen Wirbels Anlass gibt. Da auf einem so frühen Stadium, in dem die Verknöcherung der Wirbelelemente soeben sichtbar wird, bereits ein fast einheitlicher perichordaler Knochenring vorhanden ist, bleibt es zweifelhaft, ob überhaupt jemals ein intervertebraler Raum die beiden Hälften getrennt hat. Damit wird die Entstehung der komplexen Wirbel in noch frühere Entwicklungsstadien vorverlegt, sie führt uns zur Bildung der Segmente, in denen die Metamerie der Wirbelsäule vorbestimmt ist. Dabei ist von besonderer Bedeutung, dass die unvollkommene Gliederung der Wirbelsäule nur an ihren beiden Enden beobachtet wird.

Wirbel mit akzessorischen Dornfortsätzen wurden zuerst bei der Scholle der östlichen Ostsee gefunden. Sie sind hier sehr häufig, und deshalb sind die Befunde an dieser Form am besten geeignet, die Beziehungen der komplexen Wirbel zur Wirbelzahl aufzuzeigen und einige der sich daran anknüpfenden Fragen zu erörtern. Grundsätzlich sind Verwachsungen am 1. und vorletzten Wirbel und am Urostyl als 1 gezählt, auch wenn am Wirbelkörper Andeutungen einer Verschmelzung vorlagen, da es zweifelhaft ist, ob es sich dann um echte Verwachsungen handelt. Im übrigen tritt dieser Fall nur sehr selten auf.

Es liegen bisher die Zählungen an 316 Schollen des Oderbank-Gebietes vor, Tiere der Jahrgänge 1928 bis 1930 (0- bis III-Gruppe).

Pleuronectes platessa (Oderbank).

insgesamt untersucht Vert. S.		davon normal	anormale Individuen mit akzessorischen Processus spinales am				insgesamt Anzahl Proc. spin.
Anz.	Häuf.		1. Wirbel	vorletzten W.	Urostyl	1. u. vorletzten. W.	
38	1	—	1 = *100%*	1 = *100%*	—	1 = *100%*	—
39	1	—	—	1 = *100%*	—	—	—
40	2	1	1 = *50%*	1 = *50%*	—	1 = *50%*	3
41	24	3	12 = *50%*	20 = *83%*	1 = *4%*	12 = *50%*	3
42	81	27	15 = *19%*	42 = *52%*	5 = *6%*	8 = *10%*	37
43	159	86	8 = *5%*	65 = *41%*	3 = *2%*	3 = *2%*	144
44	42	34	—	8 = *19%*	—	—	112
45	6	6	—	—	—	—	17
n	316	157	37 = *11,7%*	138 = *43,7%*	9 = *2,9%*	25 = *7,9%*	316
M	42,71	43,06	41,7	42,38	42,2	41,4	43,30

Nicht weniger als die Hälfte aller Individuen zeichnen sich durch den Besitz akzessorischer Spinalfortsätze aus, und bei 8 % finden sie sich sogar an beiden Enden der Wirbelsäule. Am häufigsten sind sie am vorletzten Wirbel (44 %), weniger häufig am 1. Wirbel (12 %); seltener besitzt das Urostyl solche (3 %). Es fällt sofort auf, dass die anormalen Wirbel umso häufiger sind, je niedriger die Wirbelzahl ist. Diese wichtige Tatsache kommt auch in den Mittelwerten für Vert. S. zum Ausdruck, die an den Exemplaren mit Anomalien an einem oder an beiden Enden errechnet sind. Sie sind sämtlich geringer als der an der Gesamtheit ermittelte Wert von 42,71, der recht gut mit den kürzlich von E. M. Poulsen[1]) für Schollen des Arkona-Beckens und Bornholm-Rügen-Plateaus angegebenen Mittelwerten übereinstimmt. Je niedriger Vert. S. in den vier unterschiedenen Gruppen von anormalen Individuen ist, desto mehr beschränkt sich die betreffende Anomalie auf niedrige Wirbelvarianten. Dies ist am stärksten der Fall, wenn sie sich an beiden Enden der Wirbelsäule findet. Dieser durchschnittlich geringeren Wirbelzahl der anormalen Tiere entsprechend muss die andre Hälfte der Individuen mit normal ausgebildetem 1. und vorletzten Wirbel einen grösseren Mittelwert ergeben; für diese ist Vert. S. = 43,06. Sind dies nun die »normalen« Schollen des Oderbank-Gebietes? Wollte man dies annehmen, so würde der bisher gültige Unterschied zwischen Baltischer Rasse und Nordsee-Rasse inbezug auf die Wirbelzahl verschwinden, ja sich vielleicht sogar ins Gegenteil verkehren, da die Werte für Vert. S. in den benachbarten Gebieten der Nordsee und des Skagerrak unter 43 liegen. Es

[1]) E. M. Poulsen. Analyses of stock and race of the Baltic plaice during recent years. Rep. Dan. Biol. Stat. XXXVII, 1932.

können jene Tiere also auch nicht, um diese Deutung gleich abzulehnen, eingewanderte Schollen der Nordsee-Rasse sein — ganz abgesehen davon, dass auch bei dieser komplexe Wirbel vorkommen.

Die Frage liegt nahe, wie diese Verwachsungen bei der Wirbelzählung zu bewerten sind. Bei der Erörterung einer ähnlichen Bildung bei *Salmo trutta* geht Johs. Schmidt von der Erwägung aus, den verschmolzenen Wirbel so zu zählen, dass die mittlere Wirbelzahl der anormalen Individuen so gross ist wie diejenige der normalen. Dies ist der Fall, wenn er ihn mit $1^1/_2$ wertet. Der Grund, warum dann die beiden Mittel übereinstimmen, liegt darin, dass der verwachsene Wirbel, ähnlich wie bei den Plattfischen, bei niedrigen Wirbelvarianten am häufigsten ist. Demgemäss liegt auch der Wert Vert. S. für diese anormalen Tiere niedriger, nämlich um 0,5 gegen den der normalen Individuen, wenn man den fünftletzten Wirbel als 1 zählt.

Um zu untersuchen, wie sich in dieser Beziehung die Ostsee-Scholle verhält, betrachten wir zweckmässig die Rumpf- und Schwanzwirbel gesondert, da ja bei einer Anzahl von Exemplaren an beiden Enden der Wirbelsäule akzessorische Dornfortsätze auftreten.

Pleuronectes platessa (Oderbank).

Vert. praec.					Vert. caud.					
				Anzahl der Proc. spin.				Akzess. Proc. spin.		Anzahl der Proc. spin.
Anz.	Häuf.	norm.	Akzess. Proc. spin. am 1. W.		Anz.	Häuf.	norm.	vorl. W.	Urostyl	
11	**2**	—	2 = *100%*	—	26	**1**	—	1 = *100%*	—	—
12	**70**	40	30 = *43%*	42	27	**1**	—	1 = *100%*	—	1
13	**233**	228	5 = *2%*	258	28	**9**	2	7 = *78%*	—	3
14	**11**	11	—	16	29	**65**	18	42 = *65%*	5 = *8%*	25
n	**316**	279	37 = *11,7%*	316	30	**182**	104	74 = *41%*	4 = *2%*	151
M	**12,80**	12,90	12,08	12,92	31	**53**	40	13 = *25%*	—	118
					32	**5**	5	—	—	18
					n	**316**	169	138 = *43,7%*	9 = *2,9%*	316
					M	**29,91**	30,17	29,64	29,4	30,38

Für Vert. praec. ergibt sich an den normalen Individuen der Mittelwert 12,90 gegen 12,08 bei den 37 Schollen mit complexem 1. Wirbel. Die Differenz zwischen beiden beträgt also rund 0,8, d. h. der komplexe erste Wirbel müsste mit $1^4/_5$ bewertet werden, damit diese Tiere das gleiche Mittel ergeben wie die normalen. Einen etwa gleichgrossen Zahlenwert hätte auch das mit einem Wirbel verschmolzene Urostyl. Anders zu beurteilen wäre der einen akzessorischen Dornfortsatz tragende vorletzte Wirbel; für diesen Fall ergibt sich als Mittelwert für Vert. caud. 29,64 gegenüber 30,17 bei normalen Individuen. Die Diffe-

renz ist 0,53, der komplexe vorletzte Wirbel ist also, ebenso wie der fünftletzte der anormalen Meerforellen, als $1^1/_2$ zu zählen, um Angleichung des Mittelwertes an den der normalen Individuen zu erzielen. Danach müsste das Mittel für Vert. S. der Individuen mit Anomalien an beiden Enden der Wirbelsäule um rund $1^1/_3$ unter dem der normalen liegen; es ist aber in Wirklichkeit sogar um $1^2/_3$ kleiner. Der Zahlenwert zweier komplexer Wirbel wäre also grösser als die Summe ihrer Einzelwerte. Eine gleichmässige Wertung der Verwachsungen ist jedenfalls nicht möglich.

Es ist überhaupt fraglich, ob es richtig ist, die Individuen ohne akzessorische Dornfortsätze als normal, d. h. als repräsentativ für die Population des Oderbank-Gebietes in bezug auf die Wirbelzahl anzusehen und dementsprechend die komplexen Wirbel mit Bruchteilen zu bewerten. Wenn man die Wirbelzahl als ein Rassenmerkmal betrachtet, so sollte man ihr eigentlich die Zahl der Wirbelelemente zugrunde legen, die in den frühesten Entwicklungsstadien der Wirbelsäule erkennbar sind, da im allgemeinen die Wirbelzahl nicht nachträglich durch Verwachsungen reduziert wird. Nach dieser Erwägung wären die Wirbel mit akzessorischen Spinalfortsätzen genau so zu bewerten wie die über die ganze Strecke der Wirbelsäule auftretenden Verwachsungen, über die eingangs gesprochen wurde. Zählen wir die Spinalfortsätze, so erteilen wir den komplexen Wirbeln den Wert 2. Dann erhalten wir die in der letzten Spalte der Tabellen für Vert. S., Vert. praec. und Vert. caud. angegebenen Frequenzen für die einzelnen Varianten. Die daraus errechneten Mittelwerte sind grösser als die bei einfacher Zählung der komplexen Wirbel gefundenen, und zwar um soviele Hundertstel, wie die Prozentzahlen für ihre Häufigkeit betragen. Für Vert. S. ergibt sich dann der sehr hohe Mittelwert 43,30, der wesentlich grösser ist als derjenige der Nordsee-Rasse, aber noch hinter den höchsten bisher gefundenen Werten zurückbleibt (43,39 im Barentsmeer östlich der Halbinsel Rybatschyi[1]), 43,58 an der Nordküste von Island[2]). Die Erhöhung der Wirbelzahl bei dobbelter Zählung der komplexen Wirhel beruht vor allem auf einer starken Vermehrung der Vert. caud., deren Mittelwert sich von 29,91 um 0,47 auf 30,38 erhöht, das Mittel von rund 30 für die Nordsee also erheblich überschreitet. Die Vert. praec. nehmen im Durchschnitt nur um 0,12 zu, von 12,80 auf 12,92, und nähern sich damit dem für die Nordsee geltenden Wert von rund 13. Es ist wohl kein Zweifel

[1]) S. Rachmanowa. Über *Pleuronectes platessa* des Barentsmeeres. II. Zool. Anz. Bd. 85. 1929.

[2]) Å. Vedel Tåning: Plaice investigations in Icelandic waters. Rapp. Proc.-Verb. Vol. LVII, 1929.

daran, dass sich die Ostsee-Scholle phylogenetisch von der Nordsee-Scholle herleitet. Die grössere Zahl der primären Wirbel der Scholle in der östlichen Ostsee entspricht der allgemeinen Tendenz, die bei einigen, beide Meere bewohnenden Arten zu beobachten ist. Ausserdem scheint jedoch noch ein anderer Faktor in entgegengesetztem Sinne wirksam. Er verursacht eine Verschmelzung zweier Wirbelanlagen und reduziert so die endgültige Wirbelzahl unter die der Nordsee-Rasse.

Im Rahmen dieser kurzen Mitteilung, deren Hauptaufgabe ist, die allgemeine Aufmerksamkeit auf die Erscheinung der komplexen Wirbel und auf die damit zusammenhängenden Fragen zu lenken, kann nicht weiter auf Einzelheiten eingegangen werden. Es bleibt nur noch zu zeigen, dass Wirbel mit akzessorischen Dornfortsätzen keineswegs auf die Ostsee-Scholle beschränkt sind und etwa ein besonderes Rassenmerkmal dieser Form bilden. Sie sind nur bei Schollen von anderen Plätzen weniger häufig. Unter 65 Schollen aus der westlichen Ostsee (Travermünde) fand ich 15 Individuen mit komplexen Wirbeln (= 23 %). Wenn man sie als 2 zählt, erhöht sich Vert. S. von 42,55 auf 42, 78. Der Mittelwert bleibt also unter dem der Nordsee-Rasse, und der Unterschied zwischen den Schollen der westlichen Ostsee und denen der Oderbank wird noch grösser. Bei 100 kleinen Schollen von der Ostfriesischen Küste stellte ich akzessorische Dornfortsätze am vorletzten Wirbel bei 12 Exemplaren, am ersten Wirbel bei einem Tier fest. Bei ihrer Berücksichtigung vergrössert sich Vert. S. von 42,86 auf 42,99. Die Häufigkeit der komplexen Wirbel ist also ein weiteres Unterscheidungsmerkmal der Schollenpopulationen verschiedener Meeresgebiete.

Anders bei der Flunder. Von dieser Art liegen einige Analysen aus

Pleuronectes flesus.

Fangort	Vert. S.						Anz. d. Proc. spin. (Mittel)
	n	34	35	36	37	M	
1. **Unterelbe**....	107	30	66	10	1	**34,83**	35,05
mit akzess..	23 = *22%*	16 = *53%*	7 = *11%*	—	—	34,30	
Proc. spin.							
2. **westl. Ostsee**.	83	6	49	27	1	**35,28**	35,52
mit akzess..	20 = *24%*	3 = *50%*	17 = *35%*	—	—	34,85	
Proc. spin.							
3. **Oderbank**....	160	4	60	87	9	**35,63**	35,84
mit akzess..	33 = *21%*	1 = *25%*	20 = *33%*	12* = *14%*	—	35,33	
Proc. spin.							
4. **Danziger Bucht**	103	2	22	62	17	**35,91**	36,17
mit akzess..	27 = *26%*	2 = *100%*	11 = *50%*	13 = *21%*	1 = *6%*	35,48	
Proc. spin.							

* davon 1 Exemplar mit komplexen Wirbeln an beiden Enden.

der Unterelbe und von mehreren Plätzen der deutschen Ostseeküste vor. (0- bis II-Gruppen der Jahrgänge 1929—1931), welche die Befunde von G. Duncker[1]) über die Zunahme der mittleren Wirbelzahl von Westen nach Osten bestätigen.

In den untersuchten Proben sind Flundern mit komplexen Wirbeln ungefähr gleich häufig (21—26 %). Deshalb differiert die Zahl der Dornfortsätze gegen die der Wirbel in allen Fällen um annähernd den gleichen Betrag, und die Unterschiede zwischen den verschiedenen Proben bleiben in gleicher Höhe bestehen. Weiterhin ist bemerkenswert, dass Wirbel mit akzessorischen Dornfortsätzen nicht auf die niedrigsten Wirbelzahlen beschränkt sind. In den beiden ersten Proben finden sie sich nur bei Tieren mit 34 und 35 Wirbeln, in der 3. Probe auch bei solchen mit 36 Wirbeln, und in der 4. Probe aus der Danziger Bucht, wo die Variante 37 relativ am häufigsten ist, wurde auch unter diesen ein anormales Exemplar gefunden. In demselben Masse, in dem die durchschnittliche Wirbelzahl aller Flundern einer Probe von Westen nach Osten zunimmt, steigt auch die mittlere Wirbelzahl der anormalen Individuen (vorletzte Spalte).

Von Kliesche und Steinbutt ist bisher nur je eine Probe aus der Ostsee untersucht worden

Rhombus maximus.
(Küste v. Mecklenburg)

Vert. S. An-zahl	Häuf.	mit akzess. Proc. spin.	Anzahl der Proc. spin.
28	1	1* = *100 %*	—
29	3	2 = *67 %*	1
30	21	5 = *24 %*	19
31	15	—	20
n	40	8 = *20 %*	40
M	30,25	29,5	30,48

Pleuronectes limanda.
(östl. Ostsee)

Vert. S. An-zahl	Häuf.	mit akzess. Proc. spin.	Anzahl der Proc. spin.
38	4	4** = *100 %*	—
39	26	7** = *26 %*	22
40	86	9* = *10 %*	83
41	34	—	45
42	2	—	2
n	152	20 = *13,2 %*	152
M	40,03	39,25	40,18

* davon 1 Exemplar, ** 2 Exemplare mit komplexen Wirbeln an beiden Enden.

Wirbel mit akzessorischen Dornfortsätzen sind in der östlichen Ostsee bei der Kliesche am wenigsten häufig (13 %). Der Anteil von 20 % beim Steinbutt der westlichen Ostsee ist etwa ebenso hoch wie bei Scholle und Flunder aus dem gleichen Gebiet (Travemünde). Die Untersuchung von Vergleichsmaterial dieser beiden Arten von anderen Plätzen steht noch aus.

Die komplexen Wirbel scheinen jedoch nicht auf Plattfische beschränkt zu sein. Auch beim Hering fand ich gelegentlich den vorletzten Wirbel,

[1]) Loc. cit.

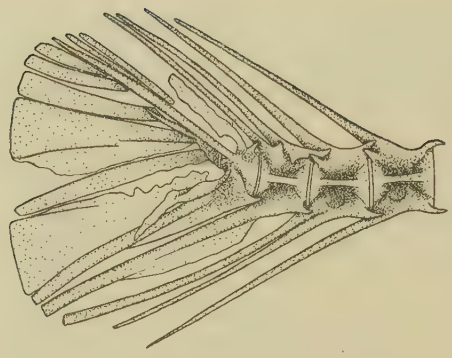


Fig. 7. Clupea harengus (Fladengrund). Länge 28 cm. 53.—56. Wirbel.

seltener den davorliegenden, durch den Besitz zweier Dornfortsätze ausgezeichnet, die völlig getrennt je einem Bogen aufsitzen oder am Grunde mehr oder weniger miteinander verwachsen sind, so dass der Dornfortsatz gegabelt erscheint (Fig. 7). Auch hier sind am Wirbelkörper keine Verwachsungsspuren zu entdecken. Bei Gelegenheit der Rassenuntersuchungen von Dr. Lissner konnte ich die Häufigkeit dieser Bildungen bei Trawlheringen vom Fladengrund feststellen.

Clupea harengus (Fladengrund).

	Vert S.						Anzahl d. Proc. spin (Mittel)
	n	55	56	57	58	59	M	
insgesamt..	580	22	257	265	35	1	56,54	56,68
mit akzess..	78	9	59	10	—	—	56,01	
Proc. spin.	= 13,5%	= 41%	= 19%	= 4%				

Wieder zeigt sich, dass die anormalen Wirbel umso häufiger sind, je geringer die Wirbelzahl ist. Insgesamt kommen sie bei 13,5 % vor, d. i. der gleiche Prozentsatz wie bei der Nordsee-Scholle.

Endlich sei noch auf eine Bemerkung von Johs. Schmidt hingewiesen, dass beim Dorsch eine Verschmelzung des dritten und vierten Wirbels, vom Schwanzende gezählt, nicht selten ist. Unter einigen kleinen Dorschen von der Oderbank fand ich ein Exemplar mit 52 Wirbeln, dessen 48. Wirbel einen einheitlichen Körper, jedoch beiderseits ein Paar Bögen und Dornfortsätze besitzt.

Es hat demnach den Anschein, dass Wirbel mit akzessorischen Dornfortsätzen eine bei Fischen weitverbreitete Erscheinung sind. Ich habe sie als »komplexe Wirbel« bezeichnet, um anzudeuten, dass sie zusammengesetzte Gebilde sind, deren Komponenten — wenigstens was die Wirbelkörper anlangt — zu einer untrennbaren Einheit verschmolzen sind. Ihre Unterscheidung von den »echten Verwachsungen« mag unrichtig sein; sie findet jedoch u. a. auch darin ihre Rechtfertigung, dass sonst die Forderung von Fr. Heincke, verwachsene Wirbel als mehrere zu zählen, auch auf die komplexen Wirbel angewendet werden müsste. Dann würden sich aber für manche bisher wohlcharakterisierte Rassen neue,

grössere Mittelwerte für die Wirbelzahlen ergeben. Das Gleiche wäre der Fall, wenn man die Individuen mit komplexen Wirbeln ganz ausschalten bezw. diese mit Bruchteilen bewerten und nur die Wirbelzahl der normalen Tiere der Berechnung des Mittels zugrunde legen würde. Es scheint mir deshalb zunächst am zweckmässigsten, bei der bisherigen Zählweise zu bleiben, komplexe Wirbel also als 1 zu zählen, jedoch ihre Häufigkeit mit anzugeben. Damit nehmen wir keine Deutung dieser Bildung vorweg, die sich vielleicht später als falsch erweist. Welcher Art die Ursachen sind, die zur unvollständigen Trennung zweier Wirbelanlagen an den Enden der Wirbelsäule und so zur Entstehung komplexer Wirbel Anlass geben, müssen weitere Untersuchungen darlegen. Der relativ hohe Prozentsatz bei Nordseefischen spricht dafür, dass es sich hierbei nicht, wie bei den echten Verwachsungen, um Missbildungen handelt, sondern um normale Entwicklungsvorgänge, die auf eine Tendenz zur Vermehrung bezw. Verminderung der Wirbelzahl schliessen lassen. Sollen wir die komplexen Wirbel als ein Anzeichen dafür auffassen, dass die Wirbelzahl doch in einem gewissen Sinne plastisch ist? Ihr Nachweis ist gerade bei solchen Arten bedeutungsvoll, deren durchschnittliche Wirbelzahlen in verschiedenen Meeresgebieten voneinander abweichen und auf eine Abhängigkeit von äusseren Faktoren hindeuten.

Summary.

In some species fused vertebrae are fairly common, particularly in the eastern Baltic. Two kinds of concrescence are distinguished.

1. True fusions with signs of suture in the centrum; malformations, of which the components are to be counted separately.
2. Complex vertebrae having a single centrum with no indications of fusion, but with accessory spinal processes on one or both sides; limited in occurrence to particular vertebrae.

It is desirable that in counting vertebrae for race studies special attention should be paid to the complex vertebrae. Within a species the individuals incline the more to this formation, the lower the number of their vertebrae. Moreover, different populations can differ by the frequency of the complex vertebrae. The reason for their occurrence is probably the incomplete separation of two vertebral rudiments in the earliest stages of development. The complex vertebrae allow us to conclude that there is a tendency to an increase or, as the case may be, a decrease of the number of vertebrae.

The Mixture of Herrings with Sprats in Catches with the Sprat Trawl, and the Composition of the Sprat Stock of the Gulf of Danzig in 1932.

By

Boris Dixon.

The Marine Station, Hel, Poland.

The application of trawling to sprat fishing during the past two years has aroused apprehensions that large numbers of young herrings are caught at the same time, and that the adoption on a large scale of trawling in place of the less intensive method of fixed gill-net fishing might lead, if not to the extermination, at least to a grave diminution of the herring population. It was therefore desirable to test the validity of these fears by analysing the composition the trawl catches, in order to determine the actual percentage of herrings. With this object in view, an analysis of 10 average samples of 10 catches taken in the Gulf of Danzig was made to determine the over-all length of the fish, the numbers of males and females, and the percentage of herrings. The length of the herrings found in each sample was also measured, in order to determine the number of the smallest herrings of the previous season, which, it was feared, trawling would eventually exterminate.

The analysis gives figures characterising the composition of hauls of sprats taken by trawls, including: 1. the admixture of herrings, 2. the relative proportion of male to female sprats, 3. a classification of sprats according to over-all body-length, 4. the mean length of males and females, and 5. the average weight of individual groups of sprats.

Admixture of herrings.

Were we to confine our examination of the question of the admixture of immature herrings to a study of the relevant literature dealing with the biology of the herrings in the Middle Baltic, we should conclude that this problem does not exist. The Swedish worker Hessle, in his paper on the catches of herring on the Swedish coast (1)[1]), is of the opinion that the

[1]) See list of titles at end of paper.

annual migration of herrings to the Swedish coastal fisheries, including regions so close to us as is the vicinity of the island of Gotland, applies only to mature fish. According to HESSLE: "The migration of the quite young autumn-spawning herrings is yet nearly unknown. So much is nevertheless evident that no considerable quantities of unripe autumn-spawning herrings stay in archipelagos during the winter, as unripe autumn-spawners are very rare even in catches there with small-meshed seines" (p. 26). In his later paper (2) this author, in finding the absence from catches of sprats of individuals less than two years old, the migration of which is also unknown, draws an analogy between this phenomenon for sprats and herrings. HESSLE's figures defining the composition of catches of herring show that the body-length characteristics of the various groups are in no case below 14 cm. It follows that the Swedish coastal shoals of herring do not contain immature forms, whence it would appear that the question of the admixture of such forms in catches with herring or sprat trawls does not arise. Nothing is known of the migration of immature herrings, and attempts at the location of shoals of these forms have up to the present been unsuccessful. HESSLE draws the above conclusions on the basis of a material, somewhat inadequate numerically, obtained exclusively by the use of gill-nets. This author on several occasions emphasises both the selective action of the meshes of these nets and the numerically small material with which he deals, but he none the less draws conclusions from it as to the composition of the population, and not as to that of the catches obtained by the use of such nets. The use of herring and sprat trawls, with a mesh of 10—18 mm. in Polish territorial waters yielded a completely different material.

Our investigations of the herring by means of herring and sprat trawls were made with the research ship "Ewa" in July—October 1931 in the Gulf of Danzig and in the Baltic. As is known, last year's season was unusually unfavourable for herring fishing in the Baltic. The cruise in July, 21st—26th, to Bornholm, in the vicinity of which herring fishing is at that time ordinarily conducted, was unsuccessful. According to information from fishermen and the Director of the Fishermen's Co-operative Society in Nexö, as well as by telephone from the Swedish port of Karlshamn, the extreme shortage of herrings and other fish placed Swedish and Danish fishermen in a critical position last year. The Swedish and Danish fisheries were in a similar position 18 years ago.

In view of these circumstances our investigations were transfered to the Gulf of Danzig and to the Baltic coast of the Hel peninsula. Trawl catches did not show the presence of herrings in any commercial quantity, but afforded a certain material, which, together with later catches of

herrings on a commercial scale in the winter of 1931—1932, allows the conclusion to be drawn that young herrings are present in Polish waters both in autumn and in winter.

The results of fishing with a 10 mm.-mesh (cod end) trawl are given in the following extract from the "Ewa's" log-book.

Date 1931	Locality; latitude and longitude	Depth	*Cl. har.*	*Cl. alosa*	Sprat	Bottom temp. °C.	Remarks
7—VII	54°51′ N. 19° 2′ E.	38	4	—	625	3.2	Gulf.
4—VIII	52°31′ 18°50′	73—66	4	—	20	5.4	„
20—VIII	54°39′ 18°50′	45—35	250	—	33	16.2	Baltic.
21—VIII	54°38′ 18°43′	47—44	170	—	—	7.8	„
21—VIII	54°41′ 18°40′	24—39	48	2	—	8.5	Gulf.
26—VIII	54°38′ 18°41′	39—30	30	1	—	5.4	„
17—IX	54°39′ 18°40′	30—16	4	1	—	13.2	Baltic.
17—IX	54°41′ 18°40′	24—40	31	247	—	13.2	Gulf.
18—IX	54°47′ 18°35′	15—14	20	17	—	12.4	„
23—IX	54°40′ 18°39′	30	360	940	220	—	„
24—IX	54°35′ 18°40′	40—29	81	1393	26	13.2	„
24—IX	54°40′ 18°39′	43	156	400	21	13.2	„
			1155	3001	945		

During the period 7. VII to 24. IX 1155 *Clupea harengus*, 3001 *Clupea alosa* and 945 sprats were caught. These not very numerous shoals of herrings found in the coastal waters consisted largely (45 %) of young individuals, measuring 9 to 13 cm. in length. The remainder measured 14 to 17 cm., with a few older individuals belonging, according to Hessle, to the Norwegian fjord race, the so called "giant herring", 20—29 cm. in length.

It appears from the above data that in the autumn catches *Clupea harengus* appears only as an admixture to the river herring, *Clupea alosa*, the quantity of which was three times greater. The body-length of *Cl. alosa* also varied from 9 to 17 cm.

The few catches of herrings made in March 1932 by fishermen using 18 mm.-mesh herring trawls indicate that the shoals of *Cl. harengus* may sometimes include individuals from different years, whilst at other times immature forms do not appear at all. A characteristic example of this is given by two catches made by two Hel fishermen on March 6—9th 1932 in the same region (10 miles SE. of Hel), and using the same trawls. On March 6th 1932 one fisherman caught 2000 Kg. and the other 850 Kg. of herrings, 17—22 cm. in length, without any admixture of smaller herrings. On March 9th one of these fishermen again caught 850 Kg. of herrings, of which only 100 Kg. consisted of mature fish, 17—22 cm. in length, whilst the remaining 750 Kg. were small individuals, 9—12 cm. in length, which were rejected as unsuitable for curing. During the winter season, apart from catches of the youngest individuals and of 5 to 6-year old herrings, 15—17 cm. in length, fairly frequent catches are made of large 7 to 8-year old fish, 25—29 cm. long. Thus, on March 19th, in the Gulf of Danzig, on a line joining Hel and Gdynia, one haul with a herring trawl gave 3500 Kg. consisting of: 1) 350 Kg. of large herrings (27—29 cm.), 2) 2400 Kg. of 15—17 cm. herrings, 3) 750 Kg. of sprats mixed with small herrings (9—13 cm.) and 4) 100 Kg. of cod.

These large 7 to 9-year old fish belong, as is shown by their scales and by the state of their gonads, to the spring race which Hessle describes as a local race peculiar to the Swedish fjords, and known by Swedish fishermen as "jätteströmingar" or "sillar" ("giant" or "real herring"). Hessle states categorically that these "giant herring" are found in no part of the Baltic except the Swedish fjords. To quote his actual words: "As a matter of fact, we never find such large herrings anywhere in the inner parts of the Baltic as in the catches of fjord herrings" ..... "We never find such large individuals in the catches from the open sea. It is *a priori* probable that they belong to the fjord herrings" (p. 41).

"Giant" herrings are, in spite of Hessle's statement, fairly frequently caught in the Gulf of Danzig and in the Baltic, and in considerable quantity (up to 350—600 Kg. in a haul). An examination of the state of the gonads of herrings caught on March 19th (350 Kg.) showed that their development was very far advanced, the male sexual glands occupying almost the whole body-cavity, and the ovaries having a distinctly granular structure. It follows that the shoals of herrings caught in the Gulf of Danzig and in the Baltic consisted of: 1. small, younger individuals, 2. mature herrings of marketable size (14—17 cm.) and 3. "giant" herrings.

In view of these findings the fears that large numbers of immature herrings are destroyed by the use of sprat trawls are not unfounded. Our analyses of representative samples of sprats caught with 10 mm.-mesh

sprat trawls show, however, that shoals of herrings avoid large, compact shoals of sprats. The greater the catch of sprats in a given haul, the smaller is the admixture of small herrings, and *vice versa*. A small admixture of small herrings is not, however, a constant phenomenon, since, as will be shown below, a large number of hauls in the general catch of sprats were entirely free from herrings.

An analysis of 7833 fish caught by sprat trawls showed that these were sprats, with the exception of 239 herrings, which were grouped according to length as follows:

Length in cm. ...	9	10	11	12	13	14	15	16	17	18	20	22	25
Number of fish ..	2	12	14	18	54	72	55	3	3	2	2	1	1

Thus, of 239 herrings caught, with a mean length of 14 cm., 58 % were of marketable size (14 cm. or more), whilst 42 % consisted of younger herrings 9—13 cm. long, which were rejected as unsuitable for curing.

The results of the analysis of 10 samples from 10 catches, defining the degree of admixture of herrings, are given in the following table:

Date of catch	Weight of catch Kg.	Number of fish in sample			Percentage of:			
		Sprats	Herrings	Total	Sprats	Herrings	Herrings under 11 cm.	
11.XII.31 ...	100	316	—	316	100	—	—	
11.II.32	250	393	52	445	88	12	6	(27 fish)
11.II.32	1750	682	58	740	92	8	6.2	(76 -)
13.II.32	9000	749	11	760	98,5	1,5	0.8	(6 -)
13.I.32	200	96	4	100	96	4	4.0	(4 -)
2.II.32	4000	234	—	234	100	—	—	
13.II.32	1000	1426	9	1435	99,3	0,7	0.3	(5 -)
17.II.32	2500	892	105	997	89	11	3	(3 -)
18.II.32	5000	1418	—	1418	100	—	—	
19.II.32	5250	1290	—	1290	100	—	—	
	29050	7594	239	7833	97	3	1.5	(121 fish)

The total number of fish examined in this way was 7833, whilst the numbers of fish in the individual samples vary from 100 to 1453. The figures given in the above table indicate that the percentage of herrings varies in the individual catches from 0.7 to 12 %, and that of small herrings from 0.3 to 6 %. The mean content of herrings amounts to 3 %, and of herrings under 14 cm. long to 1.5 %.

In practice the position is not so serious as might be deduced from these figures, since, as has already been stated, herrings are as a rule absent from the larger, compact shoals of sprats. Thus, catches of 4000,

5000 and 5250 Kg. consisted of sprats alone, and a catch of 9000 Kg. contained barely 1.5 % of herrings.

The above data allow us to draw the conclusion that the greatest harm is caused by sprat trawling when the trawl encounters scattered shoals of sprats. Such shoals nearly always contain a certain admixture of small herrings, but the percentage found is too small to justify the opinion that this procedure endangers the existence of the herring fisheries.

The question of the composition of catches of herrings made with the 18 mm.-mesh herring trawl arises in connexion with that of the admixture of herrings in hauls of sprats. The above-cited example of a catch of 850 Kg. of herrings, of which 750 Kg. consisted of individuals 9—12 cm. in length drew our attention to the occurrence in catches of immature individuals. There can be no doubt that whilst 18 mm. gill-nets exert a selective action, the herring trawl does not, retaining everything it encounters, including immature, 9 cm. herrings. Unfortunately, the absence of herrings from Polish waters during the present year has not allowed us to accumulate the necessary data for the study of this question, so that work in this direction has been put off to the next herring season.

Dimensions of sprats.

The following table gives the absolute and relative numbers of sprats, classified in groups according to their size.

Length cm.	Number of fish	Number per mille
9	11	1
9.5	127	18
10	644	90
10.5	1186	170
11	2237	330
11.5	1450	210
12	972	140
12.5	213	30
13	44	6
13.5	9	5
14	1	—
	7084	1000

The body-length of 7084 individuals measured varies from 9 to 14 cm. with a mode at the 11 cm. group. The extreme groups, consisting of fish less than 10 cm. or more than 12.5 cm. in length, are represented by very few individuals. An analysis of the composition of catches shows the extremely small number of individuals 9—9.5 cm. in length, and the complete absence of those less than 9 cm. long. Since the filtration of

such small sprats through the 10 mm.-mesh of the sprat trawl is not conceivable under large-scale trawling conditions, with catches of up to 9000 Kg., the absence of small sprats from the catches must be ascribed to the fact that this group does not participate in the autumn and winter migration. 94 % of the commercial catches consists of sprats 10—12 cm. in length, with only 6 % of smaller or larger fish; of this 6 %, 4.1 % is represented by sprats over 12 cm. long, and only 1.9 % by fish 9—9.5 cm. in length. With the exception of individual specimens 13 cm. long (11 %) the sprat population consists of two-year old fish, with two summer periods and one winter ring in the scales.

Composition of the stock with regard to sex.

Of 7084 sprats examined, 4050, or 57 %, were males, and the remaining 3034, or 43 %, were females. This observed excess of males over females applies not only to the sum total of all the sprats examined, but also to each sample from each individual haul. The ratio of males to females found by us in 1932 differs little from that found by Szela (3), according to whom of 5249 sprats 55 % were males and 45 % females. According, however, to Sund, Heidrich, Ehrenbaum, and Hessle (4, 5, 6) the proportion of males is always smaller than is that of females. This difference is, in our opinion, ascribable to the fact that the above authors used gill-nets, which might have allowed smaller fish to pass through their meshes.

Hessle finds the following percentages of males and females:

July-September	Coastal waters	70 %♀	30 %♂	(1078 fish)
June	Open sea	63 %♀	37 %♂	(855 fish)

An analysis of gill-net catches made by the author in 1923 and Szela in 1930 (simultaneously with trawl hauls) gave the following figures: —

1923, May. Coastal waters at Hel	73 %♀	27 %♂	(1850)
1930, March. At Schiewenhorst, Gulf of Danzig	52,7♀	46,3♂	(2135)

These figures show that catches of sprats with gill-nets contain a larger percentage of females than of males. This is due to the passage of the smaller males through the meshes of the net.

For this reason the sprat trawl, which has not been used by previous authors, alone gives figures truly representing the sprat population.

Dimension of males and females:

The table and curve given below express the numerical proportions of length-groups of males and females:

Body-length cm.	Males		Females	
	Number of fish	Percentage	Number of fish	Percentage
9	6	0.1	5	0.1
9.5	86	2 0	41	1.3
10	401	10	243	8.0
10.5	813	20	373	12.2
11	1650	41	687	23
11.5	768	19	772	25
12	288	7	684	23
12.5	34	0.8	179	6
13	4	0.1	40	1.2
13.5	—	—	9	0.2
14	—	—	1	0.02
	4050	100	3034	100

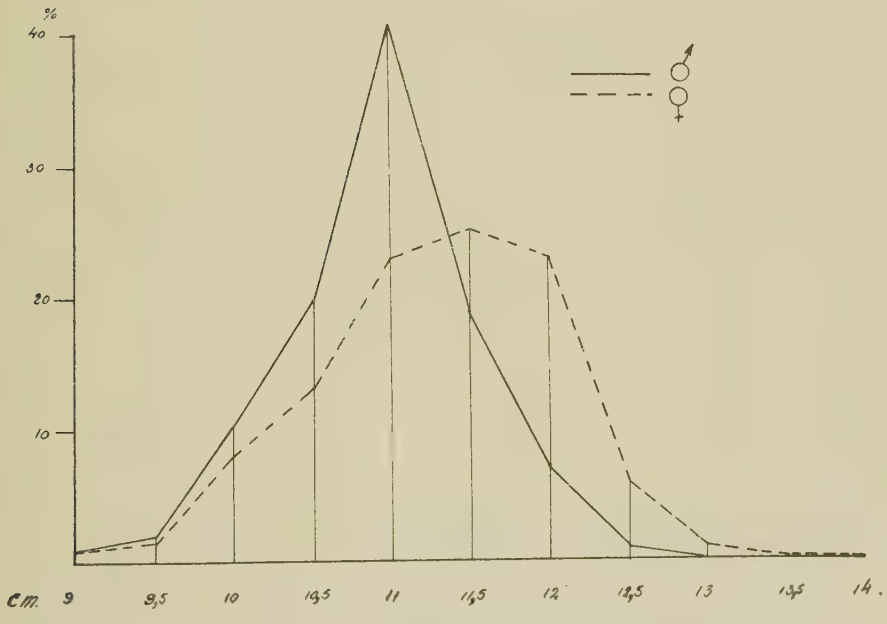


Fig. 1.

We have two typical transgressional curves, with a mode for males 11 cm. long, and for females 11.5 cm. long. To find whether there is any real difference in the lengths of males and females, we shall try to analyse statistically the numerical data concerning the body-lengths of representatives of both sexes. A statistical analysis of the data dealing with the body-length of sprats of both sexes leads to the consideration of the following two series of variants: —

Body-length classes in..	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	$M \pm \sigma \pm m$
P	6	86	401	813	1650	768	288	34	4	..	..	$10.9 \pm 5.0 \pm 0.007$
P	5	41	243	373	687	772	684	179	40	9	1	$11.5 \pm 0.7 \pm 0{,}001$

$$\frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}} = \frac{11.5 - 10.9}{\sqrt{0.001^2 + 0.007^2}} = \frac{0{,}6}{0.122} = 4.9 > 3.$$

The difference between the body-lengths of males and females is thus actually a mean value, since the body-lengths (M) of males and females can be considered as belonging to different classes of variants. The difference between the average body-lengths of the two sexes amounts to 0.6, and the mean error of this difference is 0.122; the observed difference is thus nearly five times as great as is the mean error.

Body-weight.

Numerous determinations of the weight of representatives of each size group (10 fish were taken for each determination) gave the following results: —

Length cm.	Average weight gr.	Number of fish	Total weight gr.
9	5.5	1	5.5
9.5	5.8	18	104.4
10	6	90	540
10.5	6.8	170	1156
11	8	330	2640
11.5	8.7	210	1827
12	9.4	140	1316
12.5	9.8	30	294
13	11.6	6	69.6
13.5	12.3	5	61.5
	Total...	1000	8014 gr.

In round figures, 1000 sprats weigh 8 Kg.

Size of catches, and the total number of fish caught.

According to the Sea-Fishery Board for Poland, 5,553,000 Kg. of sprats, or 666,625,000 individuals, were caught from October 1st 1931 to April 1st 1932. In comparison with previous years, this sprat season was a record one. The unusually abundant catch was due not only to favourable physico-biological conditions, but also largely to the introduction of the sprat trawl, which became generally used among the fishermen. The catch of sprats for the 12-year period 1920—1932 amounts to 17,127,418 Kg. of which 8,416,323 Kg. were taken during the first 9 years, before the introduction of sprat trawling, and 8,711,095 Kg. in

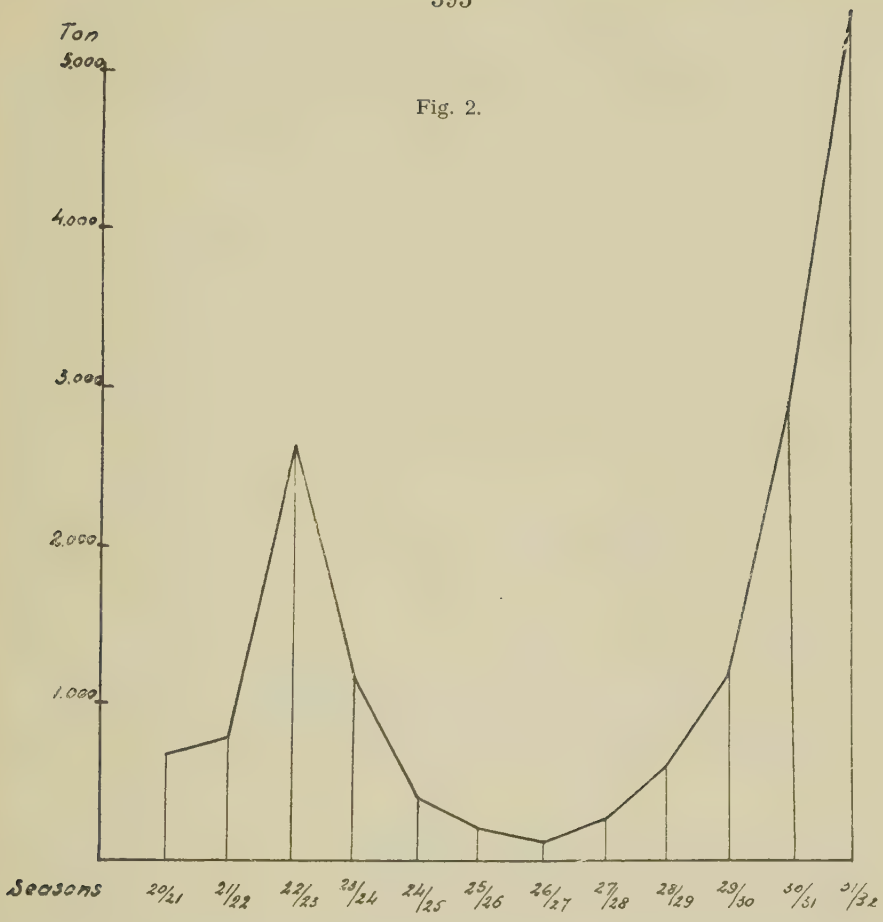


Fig. 2.

3 years during which sprat trawls were in use. The mean yearly catch in the first 9 years amounted to 935,147 Kg., as compared with 2,903,698 Kg., or 3 times as much, in the last 3 years. Whether the general use of the sprat trawl over the whole of the Baltic Sea will affect adversely the sprat population will be shown by the figures for future years.

In the meantime, a distinct upward tendency is observable in the catches for the past 5 years, as is shown by the following figures for the seasons 1920—1 to 1931—2 (April 1st—May 31st).

1920—1	Season	736,850	Kg.	1926—7	Season	164,855	Kg.
1921—2	—	881,003	-	1927—8	—	331,195	-
1922—3	—	2,685,750	-	1928—9	—	647,660	-
1923—4	—	1,259,400	-	1929—30	—	1,271,830	-
1924—5	—	437,780	-	1930—1	—	2,930,845	-
1925—6	—	247,000	-	1931—2	—	5,533,250	-

Thus a steady increase in the catches is to be observed, beginning with the season 1926—7, each successive catch being nearly twice as great as that of the preceding year. This is illustrated by the curve on p. 395.

We see from the curve that the catches diminish from the season 1921—2, to a minimum of 164,855 Kg. in 1926—7, after which the curve again rises, exceeding the highest value for gill-nets during the season 1930—1 and 1931—2, when the use of trawls had already begun. The curve has thus two maxima, which leads one to suppose that the catches of sprats vary periodically.

Literature.

1. Hessle, Chr. The herring along the Baltic Coast of Sweden. Publication de Circonstance, No. 89.
2. Hessle, Chr. Sprat and Sprat-fishery on the Baltic Coast of Sweden. Meddelanden från Kungl. Lantbruksstyrelsen Nr. 262. Stockholm, 1927.
3. Szela, T. O wybierającym działaniu włoku i sieci stawnych przy połowach szprotów. Ryba, Bydgoszcz, Poland 1930.
4. Sund, O. Undersøkelser over Brislingen. Aarsberetning vedkommende Norges fiskerier for 1910. Bergen 1911.
5. Heidrich, H. Über die Fortpflanzung von *Clupea sprattus* in der Kieler Bucht. Wissenschaftl. Meeresuntersuch. Helgoland. Bd. 20, Heft 1. Kiel 1925.
6. Ehrenbaum, E. Mitteilungen über die Lebensweise unserer Fische. Der Sprat oder Breitling. Der Fischerbote, 1919, 1920.

Salmon Caught in the Vicinity of the Tyne, 1927—1931.

By

B. Storrow, M. Sc., A. L. S.

We have now five years' data for the salmon caught in the Tyne fishery district and it is considered desirable to report on these and make them available for comparison with other data. Some indication is given also as to how fluctuations in Tyne salmon are associated with other changes.

The examination of scales was commenced in 1927, when Mr. J. A. Williamson, Clerk to the Tyne Salmon Conservancy Board, arranged that the bailiff on duty at North Shields should collect scale samples from the fish caught by sea nets. The Tyne salmon district extends from

Newbiggin Point to Souter Point. During the period of these investigations more fish have been caught by nets drifting with the tide and outside the three-mile limit than in pre-war years. The number of fish examined and the catches are here given.

Year	1927	1928	1929	1930	1931
Examined	335	170	452	232	432
Catch (Net)	30,139	20,067	12,766	2,160	13,527

A further comparison between the fishery and the sampling may be made by taking the average weights of the fish yielding the samples and those of net-caught fish. The latter are from data in the Reports of the Tyne Salmon Conservancy Board.

Average Weight of Tyne Salmon (Pounds).

Years	1927	1928	1929	1930	1931
Nets	14.2	13.6	14.5	11.5	13.1
Samples	15.4	17.6	14.5	13.6	13.5

In both 1927 and 1928 sampling was commenced rather late in the season, and the April fish, and also the May fish to some extent, are not in proportional numbers. In 1930 the samples of early fish were too few also, but some of the difference in weight is due, probably, to my expressing a wish that the samples in July and August should contain representatives of fish heavier than grilse. It is probable that there were higher numbers of grilse in 1930 than the samples indicate. The way in which the April and May fish influence the average weight for the season is indicated by the data given below for 1931.

Average Weight of Fish Sampled in 1931 (Pounds).

Month	April	May	June	July	August
Weight	10.4	12.0	13.7	15.1	16.1

The earliest set of scales showing growth for the year of capture was taken on 27th April, 1931. As a general rule this growth is not noticed until May. In 1927 it was the 19th of May before it was observed, but by the end of May, or early June, it is usual for practically all scales to show evidence of growth.

The chief class of fish examined consisted of those with two complete years of sea life — small fish. Large fish with three complete years of sea life were of next importance. Grilse were few and their numbers varied.

Very large fish with four complete years of sea life were of less importance than fish which had spawned in a previous year. The value of these classes may be gathered from the following data.

Classes of Tyne Salmon from Scale Samples, 1927—1931.

Class	Grilse	Small	Large	Very Large	Spawned	Total
Numbers....	126	1138	292	24	41	1621
Percentages .	7.8	70.2	18.0	1.5	2.5	

The earliest grilse was scaled on 19th June, 1930, but grilse are not common in June and it is not until the middle of July that their numbers are noticeable.

Fish with two complete years of sea life as well as those with three and four years may be taken anytime throughout the season.

Fish with a spawning mark on their scales varied in occurrence with the interval since spawning. Those caught early in the season were invariably fish which had had a complete year of sea life since the spawning, while those which had growth for their year of kelt recovery only were taken later. Only one kelt without growth for the year of capture was scaled; it was taken in a sea net, 15th May, 1927, and it was obvious that recovery was partial only.

Salmon with Spawning Mark on Scales (Numbers).

Captured.....	Sp. M.	Sp. M.+	Sp. M. 1.	Sp. M. 2.
Before 1st July ...	1	—	20	1
After 1st July.....	—	11	8	—

The weights of the different classes of fish may be gathered from the data given below.

Weights of Tyne Salmon (Pounds).

	1927		1928		1929		1930		1931	
Class	Range.	Aver.	Range.	Aver.	Range.	Aver.	Range.	Aver.	Range.	Aver.
Grilse.....	4-12	7.5	—	—	4-12	7.2	$2\frac{1}{2}$-9	5.8	4-12	7.2
Small.....	8-28	14.5	9-26	14.2	6-25	12.1	6-21	12.3	6-30	13.4
Large.....	13-35	22.5	13-38	26.1	9-39	20.0	11-28	19.6	12-32	20.2
V. Large ...	31-42	38.3	31-43	36.8	20-45	36.5	25-$50\frac{1}{2}$	36.5	22-26	24.0

The considerable amount of overlapping in the ranges of weight for the different ages is not due altogether to capture at different times of the season and growth made during the year of migration to the coast.

If we take the small fish, two complete years of sea life and the predominant class, it is found that fish less than ten pounds can be caught in any month from April to August; in July, 1931, fish of this class ranged from 8 to 30 lb. The following data indicate variations throughout the season of 1931.

Fish with Two Years of Sea Life, 1931 (Numbers at Pounds).

	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	Totals.
April	40	19	—	—	—	59
May	47	38	11	—	—	96
June	21	39	19	5	—	84
July	4	32	23	12	1	72
August	3	32	19	11	2	67

Weight gradually increased during the season, but fish from 11 to 15 lb. gave highest numbers after April, even in July and August when heavier fish became more numerous. The data for 1927 show a scarcity of 16 to 20 lb. fish in July, yet they were common in both June and August; the average weight for July was 3 lb. less than that for June.

Fish with Two Years of Sea Life, 1927 (Numbers at Pounds).

	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	Totals.
May	13	46	9	—	—	68
June	—	21	19	2	—	42
July	2	24	5	2	1	34
August	1	24	17	4	3	49

Different waves of migrants coming to the Tyne fishery are indicated. In April most of the small fish weigh about 8 to 12 lb. This weight increases in May and early June when fish appear showing growth for the year of capture, and along with these new migrants there are heavier fish for age. Later, in July, another wave of migrants may, or may not, as in 1927, be added to by fish which are large for their age. These late and heavy fish may not arrive until August. There are fish with at least two different types of growth coming into the Tyne area. To explain this difference we may assume a difference in growth potentiality and a difference in sea migrations. We know little about either; it is far from sure that food alone is the dominant factor producing growth. Sea fish vary in size according to the grounds on which they are captured, as has been shown for both the haddock and the herring. With regard to the latter it appears that narrow waters give small fish and oceanic waters give

large fish, and that growth areas may change. Does the same hold good for the salmon? The great differences found in size justify us in assuming that the salmon giving the Tyne fishery have been scattered over a wide area during their sea life and have been influenced by different conditions affecting growth.

The river life of the salmon giving the fishery of the Tyne district varies from one to three years. Those with two years of river life are of much the greatest importance.

River Life (Percentages).

Years	1	2	3
1927	8	83	9
1928	14	70	16
1929	12	80	8
1930	6	82	12
1931	9	83	8

The numbers with the different periods of river life are not the same each year nor throughout the season. The following data for 1931 show that fish with only one year of river life were later arrivals than the others.

River Life 1931 (Numbers).

Month	1	2	3	Years
April	2	52	12	
May	—	98	8	
June	5	75	6	
July	17	66	8	
August	14	67	2	

Variations in river life found in the samples for different years are shown below.

River Life (Percentages).

Season		1	2	3	Years
1927	To end of June	7	82	10	
	July and August	9	83	8	
1928	To end of June	6	73	21	
	July and August	25	66	10	
1929	To end of June	12	81	7	
	July and August	13	78	9	
1930	To end of June	14	73	13	
	July and August	2	86	12	
1931	To end of June	3	87	10	
	July and August	18	76	6	

Three years, 1928, 1930 and 1931, give outstanding variations in the numbers of fish with one year of river life. In 1930 there were high numbers of grilse in the catches and not one of those examined in July and August had only one year of river life; the fish with such a river life had had two complete years in the sea. In both 1928 and 1931 the numbers with only one year of river life were much higher in July and August than earlier in the season; these fish, with the exception of 4 grilse in 1931 and one large fish in 1928, had had two years of sea life. In 1929, fish with three years of sea life and only one year of river life accounted for nearly half the fish showing such a river life during April and May. For two years, 1928 and 1931, there is evidence for the late arrival of fish with two years of sea life and one of river life; for one year, 1929, there is evidence of their early arrival if their sea life has been continued into the fourth year.

The late arrivals of 1928 and 1931 arose from the hatching seasons of 1925 and 1928 and the smolt migrations of 1926 and 1929. It would appear that during 1925 and 1928 there were factors influencing the young fish in the streams and that these influences were responsible for some smolts migrating to the sea at an earlier age than usual.

Variations have been found also in the percentages yielded by the various classes of fish.

Sea Life (Percentages).

Years	1	2	3	4
1927.....	12	68	18	1
1928.....	—	73	23	3
1929.....	3	68	29	1
1930.....	25	52	19	4
1931.....	5	88	6	+

The numbers of grilse in 1927 and 1930 preceded the high percentages of small fish in 1928 and 1931. The small fish of the good year of 1927 and the comparatively good year of 1928 were followed by the highest percentages of large fish in 1928 and 1929. The value of the predominant class of fish, small fish, decreased from 1928 to 1930 and increased in 1931. Associated with these changes there has been change in the value of the year-classes contributing to the fishery. A year-class may contribute to the fishery for five years and it is of greatest value in its fifth year of life. The term year-class refers to the year in which the fish were hatched.

Year-Classes (Percentages).

Year	1921	1922	1923	1924	1925	1926	1927	1928	1929
1927.....	2	22	60	15	1	—	—	—	—
1928.....	1	4	33	50	12	—	—	—	—
1929.....	—	—	2	32	54	11	—	—	—
1930.....	—	—	—	8	19	45	27	—	—
1931.....	—	—	—	—	1	12	74	11	1

In the good year of 1927 one year-class contributed 60 per cent. of the catch. As the catches decreased from 1927 so did the percentage of the predominant year-class, or practically so, until the poor fishery of 1930, when the year-class of 1927 was of greater value than that of 1925. During a declining fishery, 1928 to 1930, the predominant class of fish dropped from 73 to 52 per cent., and the percentage of the predominant year-class of the previous season dropped from 33 to 19 per cent. Year-classes gradually became less rich from that of 1923 to 1926. With the advent of the 1927 year-class we got the grilse of 1930 and the high percentage of small fish (88 per cent.) in 1931.

The contributions made to the fishery by the different year-classes can be estimated in another way. For this purpose it is necessary to assume that the scale sampling is fairly representative of the fish landed at North Shields and that the North Shields landings represent the run of fish to the river. I know of no reason for supposing that the sampling does not represent the North Shields fish so far as sea life is concerned; for the latter point, scale samples from fish caught after August and when the net fishing has ceased are needed to ascertain if amongst late run fish there are high numbers with only one year of river life. By taking the percentage values of the year-classes and the season's catch (net) we get the following figures.

Yields of Year-classes.

Season	1921	1922	1923	1924	1925	1926	1927	1928	1929	Catch
1927	600	6,600	18,000	4,500	300	—	—	—	—	30,000
1928	200	800	6,600	10,000	2,400	—	—	—	—	20,000
1929	—	—	260	4,160	7,020	1,430	—	—	—	13,000*
1930	—	—	—	160	380	900	540	—	—	2,000*
1931	—	—	—	—	135	1,620	9,990	1,485	135	13,500*
Totals	800	7,400	24,860	18,820	10,235	3,950	10,530	1,485	135	

* 1 per cent. distributed amongst year-classes.

The best year-class is that of 1923 which yielded approximately 25,000 fish in three years of fishing, and the worst year-class is that of 1926 with 4,000 fish for the same period. So far as the evidence goes the fifth year of a year-class gives the highest yield, but in 1930 there were only 900 fish from the 1926 year-class as compared with 1,430 and 1,620 in 1929 and 1931 respectively. That the year-classes of 1925 and 1929 contributed to the fishery in their third year while those of 1926, 1927 and 1928 made no contribution until their fourth year may be due to inadequate sampling and can have no significance without further support for variations in these year-classes.

If these changes in the value of year-classes be considered as mainly due to hatching seasons and the numbers of spawning fish, omitting the smolt mortalities and sea life, we have a deterioration of hatching seasons from 1923 to 1926 with an improvement in 1927. With regard to the probable numbers of spawning fish we can refer to the catches which were:

Catches of Salmon, Tyne Nets.

Year	Number	Year	Number
1922.....	10,303	1926.....	10,190
1923.....	4,298	1927.....	30,139
1924.....	3,898	1928.....	20,067
1925.....	4,485	1929.....	12,766

Fig. 1.

The catch of 1922 was comparatively good and it could be expected that reasonable numbers of spawning fish would be on the beds to give the year-class of 1923. Judged from the catches, the runs during 1923, 1924 and 1925 to give rise to the year-classes of 1924, 1925 and 1926 were poor. The run of 1926, giving rise to the year-class of 1927, may be assumed to have been good. Since 1922 we can assume, with some reason, that the catch of one year has given an indication of the wealth of the fishery five years later.

Whilst we may conclude that runs of fish, as indicated by catches, have their influence on catches made five years later, an examination of the catches graphed in figure 1 shows that this assumption cannot be regarded as invariably true. Using the terms good and poor in a comparative way and with reference to the state of the fishery at the time, we can find good runs followed by good catches, poor runs followed by poor catches, good runs followed by poor catches and poor runs followed by good catches. The yield of the Tyne area from 1902 to 1911 is of interest with regard to this matter.

Run		Catch	
1902	13,948	1907	13,697
1903	11,702	1908	12,143
1904	9,242	1909	19,144
1905	18,807	1910	17,341
1906	9,284	1911	17,392

There are some outstanding points in connection with the fluctuations in catches of salmon made in the Tyne area. Reference has been made to these already in "Cullercoats Herring Investigations and their Relation to other Marine Work: An Essay on Fluctuations", Proc. Durham Phil. Soc., Vol. VIII. Pt. 3., 1930, and it will be necessary to do no more than summarise here.

The increased catches of 1921 and 1922 were associated with increased activity of the Atlantic which gave an increased flow of Atlantic waters into the North Sea. This was a flow of surface waters, for it brought surface floating organisms which are not usually found in numbers in North Sea waters. Associated with a change in oceanic circulation there was a change in Tyne salmon catches.

The effect of pressure distribution, which accompanied this flow of surface waters and the drought of 1921, gave rise to still further change in the North Atlantic. There was a mass of warm water to the north-west of Scotland in late 1922 and early 1923, and this water owed its origin

to an increase in the strength of the North-East Trades in late 1921. Stronger "Trades" added to the speed of drift circulation in the North Equatorial Current and afterwards in the Gulf Stream, along which warm water travelled into the northern North Atlantic. At the same time the Labrador Current gave a large body of cold water in the western Atlantic. Pressure was high over the cold water and low over the warm water. The gradient for northerly winds was higher than usual and conditions made for a stormy winter, 1922—23. It was with these wintery conditions that the 1923 year-class came into being.

Following the increased flow of the Labrador Current in 1923 there was a decreased flow in 1924, when this current was so weak as to be indiscernible off the eastern edge of the Grand Bank at least once in the ice season. Two years after the cold Labrador Current offered less opposition to Atlantic circulation there was evidence of increased activity of Atlantic waters off north-western Europe. But, this time, it was the intermediate layers which were more active, and, instead of finding floating organisms in the North Sea, Atlantic fish such as Ray's Bream were obtained. From the data available this flow influenced the North Sea in 1926, it was at its height in 1927 and died away in 1928. Tyne salmon catches fluctuated as if the numbers of fish coming into the area depended on oceanic circulation. But it has to be noted that the year-class of 1923 was in existence and gave the fish necessary for the migrations, especially those of 1927 and 1928.

In 1929 there was another drought and again floating Atlantic organisms (Pteropods) were found in Northumberland waters and in greater quantities than ever before experienced. It was suggested that, the stock of fish being sufficent, there was a possibility of increased Tyne catches in 1930. The assumption was that the change in oceanic circulation would influence salmon migrations in the Tyne's favour. There is little doubt that migrations were influenced, but there is still less doubt that the Tyne district was not benefited. The year-class which should have made the greatest contribution to our fishery was that of 1926. These are the contributions made to the Tyne fishery by this year-class.

Yields from 1926 Year Class.

Year	1929	1930	1931
Numbers	1,430	900	1,620

Fish in their fifth year are the most important as a general rule and the 1926 year-class was in its fifth year in 1930. It is evident from the

contributions made by this year-class in 1929 and 1931 that it was present in the sea in sufficient numbers to give more than 900 fish in 1930. We are forced to the conclusion that the sea migrations of this year-class had been altered and that the probable cause was the Atlantic flow of 1929, biological evidence of which was obtained off the Northumberland coast in September and October.

In both 1927 and 1930 unusual numbers of grilse were taken in the Tyne area, especially in 1930. It would appear that there is a possibility of sea migrations being affected by the age of the fish; the grilse came to the area, but those which should have given the catches of small fish in 1930 were diverted elsewhere if they made their usual coastal migrations in that year.

On three occasions we have evidence which justifies us in associating fluctuations in Tyne salmon catches with oceanic conditions. Two of these benefited the Tyne district and one did not. But, the latter does not alter the fact that salmon migrations, whether beneficial to the Tyne or otherwise, have been associated with changes in currents. The production of an exceptionally good year-class was associated with peculiar wintery conditions in 1922—23 and these with oceanic conditions also. The years 1925 and 1928, which gave rise to so many one year old smolts, present a peculiar problem worthy of further consideration. As a working hypothesis, arising from the fact that the smolt life during 1925 and 1928 preceded the changes noted above for 1926 and 1929, it is suggested that conditions in the Atlantic influence pressure distribution and that atmospheric circulation influences our climate some time before oceanic circulation brings change in the waters off our coasts.

Obviously the next step is to compare the Tyne with other salmon fisheries, but data are not available. That the salmon and its fluctuations present a national rather than a parochial problem is indicated by comparison of the following data, those for the Wye being due to the courtesy of Mr. J. A. Hutton.

Catches of Salmon, 1925 to 1931.

Year.....	1925	1926	1927	1928	1929	1930	1931
Tyne (nets)..	4,485	10,190	30,139	20,067	12,766	2,160	13,527
Wye (totals).	7,337	9,402	10,807	9,725	5,751	2,868	3,500

A Notice of Fish Marking

to be carried out by

the Hayatomo Fisheries Institute, Tobata-Shi, Japan.

Type Silver plate with two holes and silver wire. Stamped J and a number.

Figure

Use Various fishes released in the Yellow Sea, Eastern Sea, China Sea and other Tropical Seas, since August 1932.

Scale of Reward On forwarding the mark with information as to place and date of capture, type of fishing gear, length and weight of the fish, and also address of the sender.... Yen 1.00.

Reception Office
1. Hayatomo Fisheries Institute, Tobata-Shi, Fukuoka-Ken, Japan.
2. Any Prefectural or State Fisheries Experimental Station in Japan.

Reviews.

H. W. Harvey. Hydrography of the Mouth of the English Channel, 1925—1928. Journ. Marine Biol. Assoc. N. S., Vol. XVI, No. 3, pp. 791—820. Plymouth, 1930.

In this paper, which is unusually well supplied with diagrams, HARVEY uses surface temperature and salinity data provided by the fortnightly samplings of cross-Channel steamers, and the data obtained on the cruises of the S. S. "Salpa". The latter relate to the sub-surface waters as well. Much attention is given to the conditions at the well-known Station E 1 (50°02′ N, 4°22′ W.). The importance of departures from the most usual temperature and salinity regimen has been recently emphasised by the finding that certain marine animals breed within narrow temperature limits; HARVEY mentions a case where the dates at which particular significant temperatures were attained differed greatly as between two years, and sees in it the possibility of a profound effect upon an animal breeding in the region of the temperature interval concerned: — 12° to 13° C. The lower temperature was attained by the offshore bottom-water some 6 weeks later in 1924 than in 1921; the higher temperature was not attained until about two months later in the later year than in the earlier. The writer examines in detail the fluctuations which have occurred from year to year in the movements of the water masses, and sees in the one occasion when an indubitable inflow of warmer water materially affected the temperature cycle (in 1921 when an accretion of heat occurred between mid-September and mid-October, that is at a time when the temperature would usually have been falling) the explanation of the subsequent singularly warm and late autumn. He speaks of, and explains, discontinuity-layer formation and breakdown, and mentions that "a series of observations" gave evidence of slight up-and-down oscillation. This tidal effect is, of course, very well portrayed by the experiences recently published by MATTHEWS concerning two places in the mouth of the Channel. HARVEY deals with the surface-sampling problem, and adduces data serving to show what errors may arise from dipping samples from the immediate surface layer. That the salinity of the Straits of Dover is greater in winter than in summer despite the greater rainfall dilution, HARVEY holds to be due to the greater strength of the up-Channel current during autumn and winter, an explanation which present-day data would permit to be advanced with greater force. Drift-bottle experiments in July and August, 1931, have shown a maximum

development of the current rounding Lands End and carrying water from the English Channel towards the Irish Sea. The evidence there obtained of wind potency in driving along the surface waters of this area at times when the Dover Straits current is held up or reversed, enables an adequate explanation to be formulated for HARVEY's experiences of summer 1928 when the western Channel became flooded with relatively fresh water of land-drainage origin. Indeed, did space permit, available current and wind data could be drawn upon to comment fruitfully upon the vagaries of surface salinity distribution and deduced circulation dealt with so fully by the writer of this very useful paper.

J. N. CARRUTHERS.

N. G. Ricketts and **P. D. Trask.** The Bathymetry and Sediments of Davis Strait. The "Marion" Expedition to Davis Strait and Baffin Bay. Scientific Results, Part I. U. S. Treasury Department, Coast Guard, Bulletin No. 19. Washington, 1932.

This part of the report of the "Marion's" work contains a narrative of the cruise (pp. 1—52), a report and a discussion of the sounding work accomplished (pp. 53—61), and a description and discussion of the bottom samples obtained at some of the places where wire soundings were made. The two first chapters are written by NOBLE G. RICKETTS, the third by Mr. PARKER D. TRASK.

Mr. RICKETTS had never before visited Greenland waters, and he admits himself that he only knew very little about Greenland when he started on the expedition; but he has been able to see a lot during the short visits to the settlements and outposts as well as during the sea cruises, and his narrative, illustrated by several photographs taken by members of the expedition, is very entertaining. He tells how they amused themselves during the short stays ashore, how the scientific work was performed at sea, and how a young polar bear was caught, which eventually became very dangerous to the people onboard.

The expedition lasted for 73 days, the total distance of the cruise being 8,100 sea miles, and 191 stations with about 2,000 observations were taken.

As to the bathymetry of the Davis Strait the results of the "Marion" expedition are very valuable. The ship was equipped with an echo-sounding device called a "Fathometer", and by means of this instrument it was possible to make a sounding not only at every station, but also to sound every half hour between stations, whenever it was possible to hear the echo from the bottom. Under favourable conditions the apparatus could be used up to a depth of water of 2,000 fathoms. The positions of the soundings were made as accurate as possible by bearings of prominent landmarks or by astronomical observations. Corrections were applied to the soundings both for variations of the speed of sound through the water column and for the personal errors. The author considers the fathometer soundings to be correct in most cases to within $\pm$ 25 fathoms.

From this chapter of the book it is evident that the author has a great knowledge of echo soundings, and he tells in a very instructive way how the work is done and the computations are performed.

With the soundings from both the "Marion" and other expeditions he has constructed a chart of the bathymetry of the Davis Strait and the waters between Cape Farewell and the Grand Banks. A copy of the chart is given in this book on a rather large scale. Certainly it is very interesting to study the chart. As to the accuracy of the contour lines it is of course impossible to judge, but it seems as if a nice appearance of the chart has been of but little interest to the draughtsman; in some places the lines are twice or three times as thick as in other places, and often neighbouring lines run together in a broad black streak. The contour interval is 100 fathoms. The data of all the soundings will appear in Part 2 of this Bulletin (The Oceanography of Baffin Bay and Davis Strait), which will probably be issued this year.

Chapter III, written by P. D. Trask, presents rather detailed mechanical analyses and a brief petrologic description of 27 deposits from Davis Strait. For this purpose the author has used three constants: 1. The median diameter, 2. The coefficient of sorting, 3. The coefficient of skewness or its logarithm; and the results of these examinations are given in tables. Furthermore, a description of the sediments and a discussion of their origin are given. A. Kiilerich.

E. H. Smith. The "Marion" Expedition to Davis Strait and Baffin Bay under the direction of the United States Coast Guard. Scientific Results Part 3. Arctic Ice, with especial Reference to its Distribution to the North Atlantic Ocean. U. S. Treasury Dept., Coast Guard Bull. No. 19.

In 1928 the United States Coast Guard made a special survey of the waters between America and Greenland in the "Marion", under the command of Lieut.-Commander E. H. Smith, who had been oceanographer of the Ice Patrol for many years. The region included in the survey extended from the Cape Farewell—Cape Race line to the southern part of Baffin Bay, and the value of the work was greatly increased by the circumstance that Commander Riis-Carstensen carried out an oceanographical survey of Baffin Bay in the Danish "Godthaab" at the same time. The present report deals with the origin and movements of the ice, and only so much oceanography is included as is necessary for the understanding of the currents.

In the view of the author the East Greenland Current is of little importance as a source of ice in the North Atlantic Ocean. Many bergs are calved in East Greenland but few get clear to sea, and it is very seldom that either pack or bergs which drift round Cape Farewell into the West Greenland Current go north of Godthaab. Smith is definitely, and rightly, of the opinion that no ice of any kind drifts from the East Greenland Current to the Flemish Cap or the Grand Bank.

Dynamic charts of the region surveyed founded on the observations of both vessels show that the surface of the sea resembles a shallow valley with a broad flat floor rising slowly northwards and contained between relatively steep sides about a quarter of a metre high. There is therefore a well-marked cyclonic or anti-clockwise circulation along the coasts, while the water in the centre line is nearly still. The East Greenland Current

turns sharply round Cape Farewell under the influence of the earth's rotation and becomes the West Greenland Current, which flows northwards at a speed which diminishes from twenty miles per day to seven miles per day as it approaches Disko I. It gives off two weak and irregular branches westwards in the latitudes of Cape Desolation and Fiskernaes, with speeds of about five miles per day, but there is no sign of the westerly drift from Disko I., which Mecking thought might carry bergs to the Labrador Current. North of Upernivik the current broadens out to the north-west, but it still shows the effects of the earth's rotation; branches enter Smith Sound on the east side and return on the west, and Jones and Lancaster Sounds on their north sides and return on the south. Smith looks upon the region off Lancaster Sound as the true birth-place of the Labrador Current. The dynamic chart does not support Mecking's view that there is a current flowing south on the east side of Baffin Bay along the 600 metre contour. The Labrador Current continues its way along the coast of Baffin Land and gives off a branch which flows into Hudson Strait for at least 120 miles before it returns on the south side. The continental shelf broadens off northern Labrador and the current moves to its outer edge. Off mid-Labrador it returns to the coast and then further south it spreads out and divides into three branches, of which the first enters the Strait of Belle Isle, the second follows the east coast of Newfoundland, and the third flows southwards along the eastern edge of the Grand Bank.

The chief source of pack ice is Baffin Bay, which is fed by the fast ice of Melville Bay and Baffin Land and the drift from the sounds; the Labrador coast does not supply much pack. Hudson Bay does not freeze except for a fringe of about six or seven miles in width along the shore, and Smith holds that on the whole it probably reduces the total amount of pack on account of its output of warm water in summer. Mecking divided the pack of Baffin Bay into the heavy "middle ice" and the lighter "west ice"; Smith, on the other hand, considers that the "west ice" is the heavier. He also attributes the open North Water at the head of Baffin Bay to winds which sweep the pack away, rather than to an upwelling of warm water; when the Smith Sound pack breaks up in June or July the North Water is choked for a time. In Hudson Bay most of the harbours are frozen at the end of October, and Hudson Strait is not considered safe for navigation until well on in July. Some of the heavy Baffin Bay pack drifts in along the northern side. The pack reaches northern Labrador in October and the Grand Bank in January and February, the bulk of it following the eastern edge southwards. Some of it may reach the Tail of the Bank in 43° N. lat., but little or none turns westwards here on account of the westerly winds which prevail at this season. The amount of pack south of Newfoundland varies greatly from year to year. Smith is in agreement with Mecking in seeing the controlling force in the northerly winds of winter, which depend on the barometric gradient across the Labrador Current. The maximum of pack on the Bank is in February, and the Patrol found no support for Mecking's secondary maximum in May.

The glaciation of all countries which could supply bergs to the North Atlantic Ocean is discussed, and Smith, like Mecking, considers that most of the bergs which go free are calved on the west coast of Greenland, on the

stretch between 69° N. lat. and 71°40′ N. lat., in which lie Disko and North East Bays. There are 14 large glaciers here and many small ones; their speed of flow is remarkable, 60 to 75 feet a day, with which we may compare the four to six feet a day of the Alpine glaciers. The "Marion" found 4,000 to 6,000 bergs lying off Jacobshavn Glacier, four or five years' supply. About ten times a year this great train of bergs starts to move with a roar which may be heard for miles and last for days, and attains speeds as great as five to eight miles an hour, or "as fast as a fox can run".

Smith estimates that on the average 7,500 bergs are calved annually from West Greenland of a size to reach the open sea and that twice as much ice is broken off as debris. Seventy per cent of them come from the Disko I. region, and only one in twenty drifts south of Newfoundland.

The buoyancy of a berg depends upon the amount of air which it contains, a very variable quantity. As the result of measurements made on ice from a berg off Newfoundland Smith is of opinion that as much as seven-eights of the mass of a berg may be below water, but at the same time he quotes Barnes as putting the fraction as low as two-thirds. Be this as it may, repeated observations made while following bergs on patrol have shown that those of deep draught and unwasted are almost entirely under the control of the deep gradient-current, and that it is only when they are spired and pinnacled in the last stages that they drift before the wind, or more correctly, somewhat to the right of it. It follows that the deep newly-calved bergs of the Disko I. region would not be blown across to the Labrador Current as Mecking supposed; rather they would drift first north, then west and finally south along the shores of Baffin Land and Labrador.

Bergs are often driven ashore on the continental shelf of Labrador by the earth's rotation. In Smith's opinion the pack tends to fend them off, so that a winter rich in pack should be followed by a summer rich in bergs.

The bergs which reach the latitude of the northern part of the Grand Bank follow three main paths. In March they tend to drift out and to pass south of the Flemish Cap. The second path is along the eastern edge of the Grand Bank, and the third is along the coast of Newfoundland. Those which take the second path begin to arrive in April, and their maximum is in May, when on the average 130 are reported south of Newfoundland. On reaching the Tail they either ground or else get into the Gulf Stream; in both cases they break up very quickly. The Ice Patrol pays most attention to an irregular area between the Tail and 41° N. lat., since bergs which get into it may drift south across the traffic lanes. For two years the Patrol made the interesting experiment of preparing dynamic charts of this region and it was found that they gave useful indications of the probable drift of bergs; it seems a pity that they were dropped so soon, though it is true that they must have made severe demands upon the time and energy of the staff.

Smith has found a strong correlation, + 0.86, between pack ice and bergs, which supports his theory that pack prevents the bergs from grounding. A system of forecasting depending upon the barometric gradients, which may be assumed to control the pack to a large extent, has been carried on since 1926. It has given fairly good results except in the abnormal

year 1929, when more than 1,300 bergs came south instead of the normal 390 and the 350 of the forecast.

The report contains an immense amount of information at which it has not been possible to hint and which should be of great value. But its usefulness has been reduced by the number of misprints, which make one disinclined to accept any of the mass of figures which it contains without referring to the originals. D. J. M.

C. Iselin. A Report on the Coastal Waters of Labrador. Based on explorations of the "Chance" during the Summer of 1926. Proc. Amer. Acad. of Arts and Sciences. Vol. 66. No. 1. Boston, Mass., 1930.

Until C. ISELIN made his cruise in the schooner "Chance" in the summer of 1926 virtually nothing was known about the subsurface waters off the coast of Labrador beyond what could be learnt from the "Scotia's" single section in 1913, running eastwards from Sandwich Bay, about 120 miles north and west of Belle Isle. The paper reviewed gives an account of the "Chance's" observations and of all others made in this region before the "Marion's" cruise in 1928.

ISELIN repeated the "Scotia's" Sandwich Bay section and made another seawards from Nachvak in about 59° N. lat., roughly 90 miles from the northern extremity of Labrador, together with some observations in the Labrador fjords and a section running south-east from Cape Race across the Gully to the Grand Bank.

The Cape Race section showed conditions similar to those reported on other occasions by the "Scotia" and the Ice Patrol; there was a surface layer of low salinity warmed by the sun and extending down to 40 metres and below it icy cold and somewhat salter water reaching to the bottom. On this occasion there was no dynamic gradient in either direction.

The Sandwich Bay section was unfortunately run across an offlying bank by both ships; their results are in close agreement. The outer edge of the cold current was marked in 1926 by a sudden rise from 0° C. to 4° C. or more on the edge of the continental shelf, within three miles of the place where the "Scotia" found it. Both ships also found the coldest water stretching seawards between the 40 and the 100 metre levels beneath a slightly warmer surface layer, and both found a slight rise of temperature at 300 metres, at the bottom of the gully between the shore and the bank. The "Chance" also found that the cold water was separated from the shore by a warm layer of surface water about 20 metres thick, derived from land drainage. The "Scotia" made no observations so close in.

The Nachvak Bay section shows the same warm surface fringe along the shore and the coldest water stretching seawards to the temperature wall, which here is only ninety miles off shore on account of the smaller width of the shelf and of the current. There are no depths of 300 metres close in, so the warm water found at the bottom of the gully off Sandwich Bay is wanting. The most striking difference between the two sections is in the dynamic gradient; the driving force off Sandwich Bay is spread over the whole of the section, while off Nachvak it is confined to a narrow strip along the edge of the shelf. The "Marion" found very nearly the same arrangement in 1928.

Hjort's observations of 1923 across the narrowest part of Davis Strait are reproduced as a section in which the cold intermediate current is seen stretching from the western slope more than half way to Greenland.

A particularly interesting section is the one made by the "Scotia" which runs seawards from White Bay for more than 600 miles. The isotherms and isohalines wind about in great confusion. Iselin has now calculated the densities and plotted them on the same section; the density curves are practically horizontal except in the Labrador Current itself.

The fjords of Labrador and Newfoundland are cut off from the unmixed Atlantic water by the Labrador Current. In White Bay, Nachvak Bay and Seglek Bay, all fjords with greater depths inside than at the mouth, the temperature and salinity is much the same as in the Labrador Current outside. A striking feature is that the land drainage in summer is so great that the surface is nearly fresh and barren of life.

Eighteen surface plankton hauls of half an hour were made in the coastal waters with a 20-mesh net and the catch was measured in cubic centimetres after adding formalin and allowing to stand. It was not easy to relate either the volume of the catch or the species present to the temperature and salinity, and the catch as a whole was poor. Many of the species of phytoplankton captured are common in the Gulf of Maine and in the Norwegian fjords. A list of 43 species is given. D. J. M.

P. E. Church. Surface temperatures of the Gulf Stream and its bordering waters. Geographical Review. Vol. XXII, No. 2. New York, 1932.

Church berichtet hier zum ersten Male über die Ergebnisse der seit 1926 auf Veranlassung von C. F. Brooks und H. B. Bigelow durchgeführten systematischen Temperatur-Messungen im Golfstromgebiet mittels Thermographen. Eine (offenbar ziemlich grosse) Anzahl von Dampfern verschiedener Schiffahrtslinien, welche das Gebiet regelmässig befahren, ist im Laufe der Zeit mit diesem modernen Messinstrument ausgerüstet worden und hat ein so umfangreiches Beobachtungsmaterial geliefert, dass es möglich war, für einen Zeitraum von $1^1/_2$ Jahren 36 aufeinander folgende synoptische Temperaturkarten der Oberfläche für das Gebiet nördlich von 30° N. und westlich von 62° W. zu entwerfen. An diesen Karten können nun sowohl die jahreszeitlichen Schwankungen der Lage und Temperatur des Golfstromes als — bei weiterer Fortsetzung der Beobachtungen — auch unperiodische Änderungen studiert werden, wie solche in der Frage der Beziehungen zwischen dem Witterungscharakter verschiedener Teile der Erdoberfläche durch Vermittlung des Golfstromes von jeher eine grosse Rolle gespielt haben.

Church weist darauf hin, dass die Thermogramme neben der bekannten Begrenzung im NW. durch den »kalten Wall« mit Temperatursprüngen bis zu 17° C. auf wenige Meilen Entfernung auch im SE. eine ständig vorhandene, deutliche Abgrenzung enthüllt haben. Er illustriert an drei Karten für die Monate Februar 1929, 1930 und 1931 die Verhältnisse im Winter. Man erkennt sehr deutlich die Wirbelbildungen entlang der nördlichen Unstetigkeitslinie, welche ja auch in den Stromverhältnissen zum Ausdruck kommen, und in denen sich Wassermassen vom eigentlichen Golfstrom

loslösen und warmes Wasser nach Norden verfrachten. Diese, immer nur vorübergehenden Abspaltungen, mögen dann oft den Eindruck erwecken, als hätte der Golfstrom zeitweise eine nördlichere Lage. Im Sommer sind bei geringeren Temperaturdifferenzen die Isothermenkarten weniger eindrucksvoll. Für eine jahreszeitliche Verlagerung des Stromes sind nur geringe Anzeichen vorhanden, obwohl recht beträchtliche unregelmässige Wanderungen beobachtet werden, bei denen aber die Breite des Stromes ungeändert bleibt.

Die jährliche Schwankung der Temperatur im wärmsten Teil betrug in den beiden Beobachtungsjahren übereinstimmend etwa 6° C. Die Abkühlung auf dem 1100 sm langen Weg von SW. nach NE. erreichte nur etwa 1,3° C.

Es ist zu hoffen, dass die sehr interessanten Messungen fortgesetzt werden. Für die künftigen Veröffentlichungen darf man vielleicht den Wunsch aussprechen, dass in den synoptischen Karten die Kurse der messenden Schiffe angedeutet und die verschiedenen Wasserarten durch Schraffur besser unterscheidbar gemacht werden. O. v. SCHUBERT.

H. Thorade. Strömungen und Zungenförmige Ausbreitung des Wassers. Gerlands Beiträge z. Geophysik. Bd. 34, Köppen-Band III. Leipzig, 1931.

THORADE deals with a question which recently has received much attention and which can be put in the form, To what extent is it permissible to draw conclusions as to currents from tongue-like distributions of oceanographic elements? THORADE turns the question around. He treats the question quite generally, but his results can be more clearly demonstrated by fixing the attention on one single element, e. g. the salinity. THORADE's question then is, What will be the distribution of salinity in a current which carries water of high salinity and is embedded in water masses of lower salinity? THORADE's mathematical analysis leads to several remarkable results, of which perhaps the most important are:

1. A tongue-like distribution of the salinity will result, even if the velocity within the embedded current is independent of depth. One is, therefore, not allowed to conclude that the maximum velocities occur near the axis of the tongue.
2. The distribution is not much altered if the velocity is greatest near the axis of the tongue.
3. If the salinity is greater below the current than above, the tongue will sink in the direction of the current even if the velocities are strictly horizontal. It is, therefore, not always permissible to conclude that the current has a downward component when the tongue points downward.

THORADE's results are of such nature that they should not be overlooked when drawing conclusions as to currents from the distribution of temperature and salinity H. U. S.

P. Freundler et **M. Pilaud.** Sur l'eau normale méditerranéenne. 1re Partie. Station Océanographique de Salammbô. Bulletin No. 19. Paris, 1930.

Die Einführung des Normalwassers und die dadurch erfolgte Schaffung der Grundlage für die heute als notwendig angesehene Genauigkeit der

Chlorgehaltsbestimmung ist ein grosses Verdienst der Internationalen Meeresforschung auf hydrographischem Gebiete. Sehr schnell und in unerwartet grossem Umfange kam das Normalwasser in allgemeinen Gebrauch und damit wurde die strenge Vergleichbarkeit der von den einzelnen Expeditionen von verschiedenen Beobachtern abgeleiteten Chlorgehaltswerte weit mehr gesichert, als es vorher der Fall war. Infolge der erschwerten Beschaffung des Normalwassers während des Krieges, wegen Zollschwierigkeiten und auch wegen der verhältnismässig hohen Kosten macht sich innerhalb der an der meereskundlichen Erforschung des Mittelländischen Meeres unmittelbar beteiligten Kreise und besonders in der Internationalen Kommission zur wissenschaftlichen Erforschung des Mittelländischen Meeres seit etwa einem Jahrzehnt eine kräftige Bewegung gegen das Normalwasser geltend. Es wurde der Vorschlag gemacht, dass sich jedes Laboratorium die zu benutzende Silbernitratlösung durch Herstellung einer genauen Natriumchloridlösung eichen sollte, also unter völliger Ausschaltung des Normalwassers. Dies ist natürlich an sich möglich und führt bei sorgsamer Arbeit zu den gleichen Ergebnissen wie die Benutzung des Normalwassers. Voraussetzung sind aber gute Laboratoriumseinrichtungen und chemisch voll durchgebildete Kräfte. Diese Bedingungen sind für hydrographische Arbeiten nicht überall erfüllbar, vor allem nicht an Bord. Das Verlassen der von der Internationalen Meeresforschung angewandten Methode wäre also ein Rückschritt gewesen. Wesentlich der Stellungnahme von M. Knudsen (Publication de Circonstance, No. 87) ist es zu verdanken, dass diesem Vorschlag nicht gefolgt wurde. Statt dessen wurde von der Internationalen Kommission zur Erforschung des Mittelländischen Meeres beschlossen, zwar an der Benutzung von Normalwasser festzuhalten, als solches aber nicht das bisher ausschliesslich benutzte Kopenhagener zu benutzen, sondern ein solches von möglichst ähnlichem Salzgehalt und der ähnlichen Zusammensetzung wie das Wasser zu dessen Salzgehaltsbestimmung es verwandt werden soll.

Entsprechend diesen Beschlüssen hat die ozeanographische Station in Salammbô (Tunis) die Vorarbeiten für Schaffung eines für deren Arbeiten geeigneten Normalwassers aufgenommen. In vorliegender Schrift wird darüber berichtet. Im ersten Teile der Arbeit sind die diese Fragen betreffenden Resolutionen und Verhandlungen sowie die diesbezüglichen Teile der Schriften von Knudsen und Giral zusammengestellt, es ergibt sich ein klares Bild der Entwicklung der Meinungen von 1919 bis 1927. Im zweiten Teile wird der für die geplanten Arbeiten aufgestellte Plan dargelegt. Es ist durch einige Versuche bereits bestätigt, dass das Kopenhagener Normalwasser für die genaue Chlorbestimmung des Mittelmeerwassers durchaus brauchbar ist, wie dies von Nikitine für das Wasser des Schwarzen Meeres bereits geschehen ist und was natürlich ganz allgemein zutrifft. Als geeigneten Bezugsort des speziellen Normalwassers hat man die Orte 45°59′ N. und 6°07′ W. (50 m Tiefe) mit Cl = 19,580 ‰ sowie die Meeresgebiete in 400—500 m Tiefe zwischen Banyuls und Tunis sowie in der Nähe der Insel La Galite mit Cl = 21,25 ‰ festgestellt. In einer späteren Arbeit soll über die endgültige Herstellung des neuen Normalwassers berichtet werden.

Eine weitere Frage, die bei den Verhandlungen der Mittelmeerkommis-

sion eine Rolle gespielt hat, ist die Ableitung des Gesamtsalzgehalts und der Dichte des Meerwassers aus dem Chlorgehalte. Hierfür lassen sich die Hydrographischen Tabellen dann nicht ohne weiteres benutzen, wenn es darauf ankommt, nicht konventionelle, sondern absolute Werte zu erhalten. Will man solche haben, müssen die Beziehungen zwischen Chlorgehalt und Gesamtsalzgehalt sowie Dichte erst für das Mittelmeerwasser durch neue Untersuchungen festgelegt werden, wie es z. B. für Wasser aus dem Golf von Alaska von T. G. Thompson geschehen ist. Bruno Schulz.

T. G. Thompson and **R. van Cleve.** Determination of the Chlorinity of Ocean Waters. Report of the International Fisheries Commission, No. 3. Vancouver, B. C., 1930.

Die "Hydrographischen Tabellen" der Internationalen Meeresforschung sind gegründet auf die Beschaffenheit des Wassers der nordeuropäischen Meere. Ihre Anwendung zur Berechnung der Dichte aus der Chlorbestimmung bei Wasser aus anderen Meeren ist nicht ohne weiteres statthaft, es bedarf des Vergleiches zwischen den bei Anwendung eines Pyknometers bestimmten Dichtewerten und den bei Benutzung der genannten Tabellen aus dem Chlorgehalt errechneten. Derartige Untersuchungen sind von amerikanischen Autoren mehrfach durchgeführt worden, zuletzt von T. G. Thompson, aus dessen Untersuchungen sich eine mittlere Differenz der σ_t-Werte von 0.04 ergab. Diese hat ihre Ursache in schwankender Zusammensetzung des Salzgehalts. Die Verfasser kommen auf Grund ihrer eigenen Arbeiten und des Studiums der Literatur zu der Auffassung, dass für deren Arbeitsgebiet der beste Weg die Dichte des Meerwassers zu ermitteln die Chlorbestimmung und Benutzung der Hydrographischen Tabellen ist.

Nach Festlegung dieses Ergebnisses haben die Verfasser die verschiedenen Methoden den Chlorgehalt zu bestimmen mit einander verglichen, nämlich die gravimetrische Methode, die Methode von Volhard und drei Variationen der Mohrschen Methode (eine von ihnen die allgemein übliche der Internationalen Meeresforschung). Die Übereinstimmung der mit den verschiedenen Methoden gewonnenen Werte untereinander und besonders mit der gravimetrischen ist so gut, dass die Verfasser die bequeme Mohrsche Methode als die geeignetste für die Chlorbestimmung ansehen. Hingewiesen sei auf die beigegebene Tabelle zur Verwandlung der Angaben des Chlorgehalts pro Liter in Chlorgehalt pro Kilogramm. Bruno Schulz.

H. Thorade. Probleme der Wasserwellen. Probleme der kosmischen Physik, 13 und 14. Henri Grand. Hamburg, 1931.

This book is intended to serve as a meeting ground for the mathematical physicist and the experimenter and observer. All types of water waves are treated, including tides and seiches, waves in canals and rivers, surface waves and their generation by wind, and ship waves. The author begins as a rule with a description of observed phenomena, and gives a running commentary on suggested explanations. The accounts are uniformly careful and critical, and usually finish with the statement of a problem

needing solution; any one of these questions would afford a valuable opportunity for further research, though not often an easy one. Special attention is given to Scott Russell's solitary wave; here the reviewer is inclined to set a problem of his own. Such a wave can apparently move forward without change of form; but the usual theory, given in Lamb's Hydrodynamics, section 187, makes the crests of waves of finite height travel faster than the troughs. Lamb's theory assumes that the velocity is the same at all levels, which is certainly an approximation, and apart from this there seems to be no reason why his theory should not apply to Russell's wave.

The references to original literature are abundant. Havelock's initials are correctly given in the body of the work, but wrongly in the collection of references. Taylor's are wrongly given, as is usual in German works.

The illustrations consist of five splendid photographs, four maps, and 110 drawings. The photograph of a bore on the Tsien-Tang is particularly striking. Harold Jeffreys.

E. Hentschel. Die biologischen Methoden und das biologische Beobachtungsmaterial der "Meteor"-Expedition. Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungsschiff "Meteor" 1925—27. Bd. X. Berlin und Leipzig 1932.

This important report gives an account of the biological methods used on the German "Meteor" expedition in the southern Atlantic and a survey of the biological observations. The greatest part of the volume contains lists and tables, viz. about 220 pages, whereas the text occupies only some fifty pages.

The author pays much attention to the programme of the biological investigations during the cruise and the scheme for the publication of results. While the biological reports of earlier expeditions have in most cases been a collection of volumes giving separate systematical accounts, the aim of the reports of the "Meteor" expedition is to give a general presentation of the biological circumstances in the sea. The most important problem of the biological investigations was to get an understanding of the distribution of the plankton in the ocean investigated. The means to obtain this result were comparison of the quantitative plankton investigations with the hydrographical results. The working methods used on board the "Meteor" had therefore primarily quantitative character.

After the account of the scientific objects of the biological investigations follows a detailed survey of the working methods used on board and during the working up of the material after the return of the expedition. In the laboratory on board, where three electrical centrifuges were installed, the author was assisted by the surgeon. The most important point on the programme of the plankton researches was a quantitative and qualitative investigation of the distribution of the nannoplankton in the various depths and regions of the ocean. On 310 stations about 1250 water samples were taken and all analysed quantitatively on board, a really gigantic undertaking. Discussing the technical arrangements, the author has a number of

criticisms to make concerning the centrifuging of water samples and the counting of organisms, which are of the greatest interest for everybody engaged in similar investigations. Besides the collection of water samples for nannoplankton investigations, 312 samples of 4 litres were preserved in formalin and put aside to settle. These sediments were investigated after the return of the expedition, when the number of metazoans was counted. Furthermore, vertical hauls with plankton nets were made and a total of 438 plankton samples were collected, mostly for investigating the distribution of the various organisms. There are many points of interest in the report which cannot be touched upon here, but the author gives in the text much detailed and useful information which should be studied with the most profound attention by all concerned with quantitative plankton work. The author puts forward suggestions regarding future investigations. According to his experience it is of the greatest importance in the future to get a more thorough biological knowledge of the uppermost layers of water in the ocean, which means before all a quantitative investigation of all kinds of organisms.

The tables in the present volume start with a list of stations and a survey of the centrifuged water-samples. Thereafter follow two comprehensive lists concerning the countings of organisms in the centrifuged samples. The first gives a survey of the number of the various organisms per 1000 cc. of water in the different depths on each station, — a convincing proof of the long and painstaking work carried out on board the "Meteor". The second shows the total number of the most important groups of organisms on the different stations arranged according to the following depths: 0, 50, 100, 200, 400, 700, 1000, 2000, 3000 and 4000 m., as well as intermediate and greater depths down to 5700 m. Then follows a survey of the sediments investigated and the metazoan counts, arranged according to the various depths. During the cruise regular countings of macroscopical organisms in the surface were undertaken and a list gives, according to the daily positions, the number of larger surface organisms, such as whales, flying fishes, Physalia etc. as also drifting sea-weed and birds observed. The volume concludes with a survey of the vertical hauls, which in most cases were made with Nansen nets (silk no. 25).

The present report contains an imposing amount of data and our thanks are due to Prof. Hentschel for producing this work, which will be highly appreciated by all planktologists. P. Jespersen.

N. Peters. Die Bevölkerung des Südatlantischen Ozeans mit Ceratien. Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungschiff "Meteor" 1925—1927. Bd. XII, Lief. 1. Berlin and Leipzig, 1932.

The dinoflagellate genus Ceratium is an excellent subject for biogeographical study, the individuals moving little and being so big they are easily caught. There are special advantages in the large cell body, the length of the horns and the thickness of the armature, all of which vary and can be studied in connexion with the environment. The species and their numerous forms are definitely known and can be examined without any treatment.

Dr. Peters has made a very careful study of these organisms in the South Atlantic and the factors which influence their distribution and variation. They occur almost exclusively in the upper water layers to a depth of about 100 metres, chiefly at about 50 metres. There are 43 species found, and at least 82 different forms, 55 being distinct species or good geographical varieties. The samples, from 209 stations, were taken with the Nansen closing net and the Apstein net and pump catches were also included. Only in the extreme south, in the neighbourhood of the ice, were no examples found; elsewhere they were abundant throughout the area investigated. This is divided into eight natural regions characterised by definite species and forms, the most southerly of these containing one species only — *Ceratium pentagonum robustum*; further south still there are none.

Regions I—IV and VII are the warm waters. I is the main part of the South Atlantic, rich in species but poor in numbers, mostly with small bodies and long, thin horns. To the north-east of this is II, the Cape Verde Region, with many individuals, thick-shelled and short horned; III, the Equatorial Region, contains the Guinea Stream, the form being variable, both long and short horns being present and the numbers few but more than in I. IV, the South-west African Region, is thickly populated with thick bodied and short horned forms. V, the Falkland Region, is chiefly notable for the species which come from the Pacific; there are here few species but they occur in large numbers. VI is intermediate between I and VIII, having numerous species similar to I (VI b being influenced by the introduction of the Agulhas Current). VII, the Agulhas Region, by the Cape of Good Hope, has a strongly Indian character. VIII, the most southerly region as before noted, has only one species.

In those regions where there is much nutrient matter and abundance of plankton the colour of the sea is greenish (the so-called eutrophic waters). Here the Ceratium population is very large but poor in species, whereas in the blue waters (oligotrophic) which are poor in nutrient matter and in plankton there are many species but much fewer individuals. On the whole the genus likes warmth and of the 55 species or forms, 33 are confined to the warm waters. Salinity appears to be less important, for although the Ceratium species prefer the waters of high salinity and avoid those of low salinity (their absence from the ice regions being probably due to this), yet in the open ocean the salinities do not appear to influence the distribution of individual species in any marked degree.

It is an interesting fact that Dr. Peters finds from these investigations that the differences in the length of the spines and width of their lists and in the thickness of the armature depend more on the abundance of food (in this case as shown by the phosphate contents of the water) than on the depth and viscosity of the sea as is generally supposed. Hentschel and Wattenberg in the results of the "Meteor" expedition have already correlated the abundance of general nanno-plankton with the abundance of phosphates and here it is shown that these conditions in that region of abundance of nanno-plankton and of phosphates apparently have an important bearing on the form of the Ceratium, short horns, large body and thick armature being characteristic as contrasted with the long horns, small body and thin armature of the oligotrophic waters. M. V. L.

W. E. Frost. Observations on the Reproduction of *Nyctiphanes couchii* (Bell) and *Meganyctiphanes norvegica* (Sars) off the South Coast of Ireland. Proceedings of the Royal Irish Academy. Volume XL, Section B, No. 14. Dublin 1932.

Nyctiphanes couchii and *Meganyctiphanes norvegica* are both important as fish food. Herring feed largely on them and so also do the sea trout, mackerel and young hake on the west coast of Ireland. Miss Frost finds that not only the adults and adolescents are taken but even the smaller larval forms. The research was undertaken in order to ascertain the breeding seasons of both species by a detailed investigation into the distribution of all larval stages and their seasonal occurrence. The area chosen lies off the south coast of Ireland, extending for about one hundred and fifty miles from north to south, and about two hundred miles from east to west, the most northerly station being on latitude 50°54′ N., and the most southerly 49°20′ N.; the station furthest east on longitude 6°21′ W., and furthest west on 11°17′ W. This includes both inshore and offshore waters. The material was collected by the S. S. "Muirchu", the research vessel of the Irish Free State Government, on her cruises made four times a year in carrying out the programme of scientific work allotted to Ireland by the International Council for the Exploration of the Sea, 31 cruises in all, covering a period of 11 years (1920—1931).

These two euphausiids are the most frequent species in the plankton of the waters under 100 fathoms and both are found also in the deeper waters. *Nyctiphanes* has not nearly such a pronounced preference for the shallower waters as it has in the Channel and the distribution of the two appears to be much the same in this Irish area. *Meganyctiphanes* is much less abundant than *Nyctiphanes*.

The results of these investigations indicate two main breeding seasons for *Nyctiphanes*, probably in spring and autumn. Larvae occur throughout the year with a maximum in April and a smaller one in autumn, the autumn brood probably maturing in the spring of the next year. *Meganyctiphanes* on the other hand appears to have only one breeding season, in spring and summer. As *Nyctiphanes* carries her eggs until after the nauplias stages it is easier to ascertain the breeding seasons than it is in *Meganyctiphanes*, which sheds the eggs into the sea, but from the data available the younger larvae apparently are not found later in the year than July. The distribution of the larvae of both species seems to be without regard to depth in water of less than 100 fathoms or to a salinity range of 34.8 to 35.5 per mille.

M. V. L.

M. Knight and **M. W. Parke.** Manx Algae: an Algal Survey of the South End of the Isle of Man. Trans. Liverpool Biol. Soc., Vol. XLV. L. M. B. C. Memoirs, No. XXX. Liverpool, 1931.

The present memoir is one of a series published by the Liverpool Marine Biological Station, most of the work being carried out in the waters of the Irish Sea, the headquarters being the Marine Biological Station at Port Erin in the Isle of Man. It contains the first instalment of the results of a comprehensive survey of the algal flora of the Port Erin neighbourhood

of the Irish Sea. Though primarily concerned with the revision of the systematic list of species occurring in that part of the island, it contains chapters which are far more than of local interest, embodying results of years of research which is of value and importance for all workers on marine algae.

The introduction includes an account of the area under investigation with notes on the conditions and the flora of the principal collecting grounds.

Preceding the main systematic portion is a list of the species added to the flora since 1913, when the last list was published. This includes in all about 100 names, the discovery of which is mainly due to the energies of the staff and students of the Botanical Department of the University at Liverpool. The revised list, which excluding the Cyanophyceae contains 349 names, gives evidence of critical examination, and it is obvious that every care has been taken to secure accuracy of determination as far as possible. Details of zonal distribution, seasonal and reproductive occurrence, are provided in all cases. A key to the genera, which is supplied, is of especial value as it aims at using only morphological characters of the vegetative thallus, rather than reproductive bodies.

A particularly interesting chapter is that entitled "The effect of alternating seasons on algal vegetation", where an account of the various types of perennation and season of growth is given and likewise a description of the periodic migration of the different littoral species up and down the shore — a phenomenon controlled doubtless mainly by the factors of light, temperature, and desiccation. It is pointed out that previous to the onset of unfavourable conditions copious spore-production of one type or another invariably takes place. The dates of the various reproduction phases are given under each species in the systematic list, and this information is summarized in a large table at the end of the volume under four vertical columns of Spring, Summer, Autumn, Winter, the various types of reproductive organs being grouped in the left-hand column. A. D. C.

A. B. Needler. The Haddock. Biol. Board of Canada. Bull. No. XXV. Ottawa, 1931.

In the special series of semipopular Bulletins which the Biological Board of Canada has issued in recent years on subjects of interest to the general public A. B. NEEDLER has published a paper on the Haddock. The author gives a brief and clear statement of the more important results of the scientific work done to elucidate the biology of the haddock, especially as regards the American waters, and deals further with the methods of capture, the marketing of the catch and finally with the use made of the waste, namely, small fish, heads, skin, viscera, and bones for preparation of oil, meal and glue.

Haddock occur on both sides of the North Atlantic, and the author draws attention to the fact that they are found much farther north on the eastern than on the western side of the Atlantic, due to the fact that the cold arctic water penetrates farther south on the American than on the European side of this ocean. In this connection it is of interest that according to Danish investigators the haddock has been caught in the West Greenland waters in accordance with the higher temperature found here in recent

years. The author further points out that haddock are rather particular in the choice of habitat; they are only found in quantity in salinities of 31.5 to 33 $^0/_{00}$. In the opinion of the reviewer these limits are drawn somewhat too narrow; in the North Sea haddock are fished in great quantities in salinities between 34 and 35.2 $^0/_{00}$, and in the western Baltic haddock have grown up in salinities varying between 18 and 24 $^0/_{00}$. The author deals fairly fully with earlier studies of the haddock, giving a clear account of the valuable results of A. W. H. Needler's thorough investigations. The haddock undertakes rather long seasonal migrations governed in the main by temperature, whereas spawning seems to be not nearly as great a factor in producing migrations — "the haddock may spawn wherever they happen to be when time and conditions are favourable". Concerning growth the author mentions the interesting fact that the American haddock grow faster than the European, the 3-year old American haddock varying in length between 42 and 50 cm. whilst the European haddock at the same age have only attained a length of 30—40 cm. The author further states that the European haddock tend to grow faster, the warmer the water is. The reviewer is, however, not quite sure that this can be maintained as a general rule. It is true that the haddock grow faster in the warmer water off the south coast of Iceland than in the colder water off the north coast. But it must be borne in mind that on the whole the haddock of Iceland (and this also holds good for the haddock from the cold east and north coasts) grow faster than those from the North Sea, although the Icelandic water is by no means warmer — rather colder — than the North Sea water. There is more reason to suppose that it is not so much the temperature as the amount of food available for the haddock that governs the rate of growth. European writers have shown that haddock grow faster in regions (the Belt Sea and western Baltic) where the food principally consists of molluscs and crustaceans than where (as in the North Sea) it is mainly composed of echinoderms, which are of little value. Concerning the question of food the author states that the haddock feed almost exclusively on bottom animals. It is further mentioned that exceptions from this rule occur, haddock having been caught with their stomachs full of young whiting. In this connection it could have been mentioned, too, that the haddock in deeper water, i. e. the Skagerak, are known to feed to a considerable degree upon *Meganyctiphanes norvegica*.

In the last part of the paper the author gives a clear and good account of the methods of capture and the use made of the haddock caught. This part of the paper is of special interest for the biologist, also as it contains information on a subject rarely dealt with in scientific papers.

The author must be congratulated upon the way in which she has been able to compile in a clear and concise form a great stock of valuable information in a paper not larger than 28 pages. Not only for the general public but also for the scientist the paper of A. B. Needler will be very valuable. Some of the figures, however, — for instance the figure showing a haddock scale — are technically not as good as desirable.

Erik M. Poulsen.

K. Altnöder. Bericht über die III. und IV. Untersuchungsfahrt zur Feststellung des Vorkommens der Herbstheringslarven in den Laichperioden 1930 und 1931. Ber. d. deutsch. wiss. Komm. f. Meeresforschung. N. F., Bd. VI, H. 2. Leipzig, 1932.

It is a well-known fact that on the initiative of the late Dr. A. C. Johansen a co-operative work between Denmark, Germany and Sweden was started some years ago in order to define by means of yearly investigations the spawning places and the spawning intensities of the Autumn Herrings from the Transition Area and parts of the Baltic Area. The main results are given every year in the Transition Area report in the "Procès-Verbaux" In the paper under review K. Altnöder reports more especially on the German investigations in the autumns of 1930 and 1931 in continuation of his report of these investigations in 1928 and 1929 (Ber. d. deutsch. wiss. Komm. f. Meeresf., N. F., Bd. V, H. 3, 1930, reviewed in Journ. du Conseil, VI, 2).

In the southern Baltic the number of larvae was exceedingly low in 1930. In 1931 the number was somewhat higher, although not nearly as many larvae were caught as in the good survival years 1928 and 1929. In the years since 1927 the following numbers of larvae per station were caught: 1927 — 43, 1928 — 86, 1929 — 194, 1930 — 7, 1931 — 23. In this connection it should be mentioned that the Danish investigations in the Belts gave a higher number of larvae in 1931 than the German in the Western Baltic. Thus it seems as if the spawning places were situated a little farther north in 1931 than is normally the case.

The paper contains tables giving the measurements of the larvae and the numbers of larvae caught with and without a yolk-sac, as well as tables and figures showing the distribution of the larvae in the various parts of the area investigated. It appears that the frequency of larvae in different areas varies from year to year; but in general the numbers of larvae are high in Kiel Bay and between Fehmarn and Darsserort, whilst the numbers are small west of Rügen, and exceedingly small in Mecklenburg Bay. North and east of Rügen normally only few larvae occur, but nevertheless in 1929 the largest amount of larvae was caught just in this area. In this connection the reviewer wishes to state that in general a larger amount of larvae is found in the waters round the southern Danish islands than off the German coast. It is to be hoped that these differences in distribution can be explained in future when investigations from a series of years are at hand, as it will be of interest to the fishery to know the factors which govern the migrations of the spawning shoals.

It is of special interest that for the year classes 1927, 1928 and 1929 the author has found a coincidence between the number of larvae caught in one year and the catch of one-year old herrings in purse seines in the next year.

In an appendix the author gives an account of larvae of other fish (*Onos*, *Ammodytes*, *Gobius*) caught while fishing for herring larvae. This part of the paper would have been of more interest if the author had undertaken the task — not very easy — of sorting these larvae not only as to genus but also to species.

For readers not especially acquainted with herring investigations it

would have been convenient if the author had mentioned the area of investigation in the title of the paper.

The interesting results of the Danish, German and Swedish herring-larvae investigations in the Belts and the Baltic as they are represented in the Transition Area reports and in Dr. ALTNÖDER's papers give an idea of what can be achieved through close international co-operation.

ERIK M. POULSEN.

California State Fisheries Laboratory. Studies of the Length Frequencies of the California Sardine (*Sardina caerulea*). Div. of Fish and Game of Calif. Fish. Bull. No. 31. Sacramento, 1931.

The two papers included under the above title are the result of an investigation carried out by FRANCES N. CLARK and H. C. GODSIL, and form part of a co-operative programme which was begun in 1919, and which has already been reported on in fourteen previous papers.

This present study deals with the composition of the commercial catches of sardines from the Monterey, San Pedro and San Diego areas, and since the work on age-determination by means of the scales is not sufficiently far advanced to give adequate results, the authors have confined themselves to a study of the fluctuations of the stocks by making continuous observations on the change in size. The present records deal with the seasons 1919—1920 to 1929—1930 inclusive, and the total measurements for each season have been shown as frequency curves in chronological order.

It is clearly shewn that during the above period three main size-groups have passed through the fishery, and a fourth appeared during the season 1929—1930. The interval of time between the appearance of these groups was not constant, but there was a period of three or four years between each group, which, incidentally, is very similar to the case of the herrings of the southern North Sea. It was found that the same changes in the sizes of the sardines occurred in the three areas studied, so it was concluded that either the three areas were receiving the same stock of fish or that similar "conditions" had produced the same dominant groups in each area.

The effect of the fluctuations in size on the fishery and the canning industry cannot be ignored, for the average number of sardines to the standard "pound-oval" can was found to vary inversely with the modal size of the incoming groups, and also it was apparent that in the event of the non-appearance of new dominant groups, the fishery and the canning industry would suffer.

The figure shewing the deviations from an eleven-year average is very instructive, for it demonstrates the even increase in size, not only of the dominant groups, but also of the deficient groups, and this knowledge of the progress of the main size-classes through the fishery has been used as a basis for forecasting future catches.

W. C. H.

H. Federighi. Studies on the Oyster Drill (*Urosalpinx cinerea*, Say). U. S. Department of Commerce, Bureau of Fisheries. Vol. XLVII, Bulletin No. 4, Washington, 1931.

As a result of ravages of the oyster drill in Hampton Roads (Virginia) and elsewhere, this research was undertaken in view of the meagreness of

existing knowledge of its biology, to provide a basis for measures which would eliminate this pest or at any rate reduce its numbers to insignificance. The damage to oyster beds on the Atlantic coast attributed to this drill is estimated at millions of dollars annually. It attacks other molluscs also, but the results are not of economic importance. The outcome of this work is of practical interest to oyster growers and planters in Europe also, for this same drill has already reached England, where it was reported in 1928 to have done great damage on beds in the Thames estuary.

The author deals with the effect of salinity on distribution, with the effect of temperature, current, and pH, and with tropisms, migration, feeding and breeding habits. He found that the salinity death-point varies with the salinity to which the drills are habituated, but is high enough to render feasible a method of "floating" oysters from infested beds for about ten days in brackish water, which destroys the drills without injury to the oysters. As the drill is practically non-migratory and has no free larval stage, the chief distributing agent is the oysterman. Measures to prevent transfer of the pest along with oysters to new grounds during planting operations are of course no less important than those for trapping and removal of the drills from grounds already heavily infested. The latter include use of the trap dredge designed to retain drills but to allow the escape of oysters taken in it, use of small concrete pillars or sand-filled buckets by which advantage is taken of the drill's propensity for climbing, the pillars being connected by buoyed wires and hauled up regularly for removal of the drills, and use of covered oyster-dredges which retain both oysters and drills. Measures recommended for freeing oysters from drills before planting include the "floating" method already mentioned, screening the oysters with suitably meshed wire-netting, and before putting them overboard during planting, dropping them on the deck from forks used for the purpose instead of shovels. Of these methods all appear to be applicable, if necessary, where beds of *edulis* may be concerned, except probably that of floating, for *virginica* will stand salinities somewhat lower than the minimum for *edulis*. Quite apart from the practical value of this paper, the observations and experiments described in it are of great interest and form a fairly comprehensive account of the biology of the species. H. P. S.

J. Hjort, J. Lie and **J. T. Ruud.** Norwegian Pelagic Whaling in the Antarctic. I. Whaling Grounds in 1929—1930 and 1930—1931. Hvalrådets Skr. Nr. 3. Oslo, 1932.

The regulations of the Norwegian Government concerning the hunting of whales require the managers of factory ships to record various details of the whales caught. The information thus acquired in the seasons 1929/30 and 1930/31 is here used by Messrs. Hjort, Lie and Ruud in a brief analysis of the stock of whales in different parts of the Antarctic, mainly in connection with the distribution of mature and immature whales. It is a short paper, but it brings forward several important facts.

The whaling grounds are considered as including five extensive areas: — 1) The sphere of the land stations in the Falkland Is. Dependencies. 2) The Weddell Sea area. 3) The "Bouvet" area. 4) The "Kerguelen" area. 5) The

Ross Sea area. Area no. 1 is that in which whaling has been prosecuted during a considerable number of years, while the exploitation of the other four areas was begun a comparatively short time ago.

A decrease in the average size of individuals in a stock of animals is generally regarded as a sign of a reduced duration of life such as might be caused by excessive hunting. The essence of the paper lies in the production of figures which show that in all five areas there is no appreciable difference between the average lengths of mature Blue whales or between the average lengths of immature ones. On the other hand area no. 1 (the old whaling ground) shows a much higher percentage of immature whales than the other four. The suggested explanation of the latter point is that the area of the Dependencies happens to lie more in the migration routes of the young whales than the newer and more southerly areas, and this is almost certainly correct. It is admitted, however, that the fact that the average length of mature and immature whales is not greater in the new than in the old grounds, does not necessarily mean that whaling has not already reduced the average length of life of the whales. This is true enough, for there is no evidence to show that the whole area covered by the land stations is inhabited by a stock of whales which do not also visit the other areas in the course of their migrations.

The records from which the authors have drawn their material are also used by the committee appointed by the Norwegian Government to compile the "International Whaling Statistics". Valuable as the latter are, it is unfortunate that they do not give more precise information as to the localities in the Antarctic from which the pelagic factory ships have taken their catches. The extra space which such material would occupy in the published statistics would not be wasted. The present paper is particularly valuable in that it summarises much of this kind of information.

N. A. M.

R. W. Butcher, F. T. K. Pentelow and **J. W. A. Woodley.** An Investigation of the River Lark and the Effect of Beet Sugar Pollution. Ministry of Agric. and Fish., Fish. Invest. Series I, Vol. III, No. 3, 1930. London, 1931.

The paper falls naturally into three sections in which the effects of the pollution are considered from the chemical, botanical and zoological aspects. The chief results are collected into a summary, pp. 62—65, where, in addition, the inter-relation of chemical and physical causes with biological effects is discussed. In attempting to review a work of this kind the lack of comparative data constitutes a serious handicap. It is really surprising how little attention has been paid to the study of rivers, and particularly of small rivers, especially when one considers their importance to the general public. This lack of data from similar environments has naturally greatly increased the difficulties of these investigators; not only have they had to develop their special technique, which they have done with conspicuous success, but also they have found themselves with no information by which to gauge the normal condition. Their attention was first directed to the problem some six months after the factory had begun to discharge its wastes,

and they had, therefore, no means of determining to what extent the subsequent recovery from the disastrous consequences of the first season's operations was complete. Moreover, while the main facts of periodicity in lacustrine flora and fauna are well known, similar information concerning even the commoner inhabitants of small rivers is virtually absent. The component species of the plankton of lakes have been figured and described from many localities, whereas the insect larvae and the encrusting algae of streams have received but little attention.

The authors naturally make no claim that their findings will be of general application; beet sugar pollution, although producing effects similar in many respects to those of sewage, is a specialised problem, and the River Lark with its semi-canalised reaches, its great production of erect water plants which form in summer a barrier sufficient to cause local flooding, is a highly specialised type of environment. There is no doubt, however, that this piece of work, with its many and interesting conclusions, is one that other workers in allied fields should make a point of consulting.

From the chemical point of view, the most obvious effect of the effluent was the deoxygenation of the river water. On occasions this was virtually complete and extended for some five or six miles. Recovery was rapid, however, for following the severe deoxygenation of the 1926—27 campaign, a period of less than one month was required for the return to normal conditions. When deoxygenation was sudden the effect on the fauna was disastrous; gradual deterioration, on the other hand, seemed to give time for the fish, at any rate, to move off to less affected reaches.

From the botanical point of view, the result of the pollution most immediately apparent was the great production of "Sewage Fungus". Under this head are usually included some dozen separable forms, descriptions of which, together with 6 figures, are given in this paper. Conditions affecting growth are discussed, and data from a number of other English rivers are included. Figure 20, p. 34, is of especial interest as demonstrating not only the daily growth of *Sphaerotilus natans* under natural conditions, but also the rôle played by this plant in the collection of silt.

An attempt was made to trace the periodicity of the algal flora throughout the year, and the conclusion arrived at was that the normal cycle was interrupted by the pollution, which prevented any considerable autumnal maximum. Great importance is attached to the vernal diatom maximum, both by reason of the part played in the re-oxygenation of the river and the colonisation of the masses of sewage fungus. The authors draw attention to a field about which little is known in their study of an association, dominant in the late summer, and characterised by the diatom *Cocconeis* and various encrusting algae (*Protoderma viride*, *Gongrosira sp.* and *Oncobyrsa sp.*).

From the zoological aspect, despite the serious handicap of the lack of data from which to gauge the normal condition, it was possible to separate the fauna into three classes depending, in the main, upon their oxygen requirements. The effect of the pollution was, very largely, to destroy the "Gammarus — Ephemerid larva — pulmonate mollusc" association, characteristic of clean, rapid stretches, with a gravel bottom, and to replace it either by the "Asellus — Sialis — Sphaerium" association or by the

"Tubificid — Chironomid" association, which alone seems able to survive the seriously deoxygenated and heavily silted conditions of the grossly polluted regions. A distinction of considerable importance is made between animals, frequently called "pollutional", which are favoured by some specific effluent and those, such as the Oligochaetes *Tubifex* and *Limnodrilus* which would seem to be especially resistant and thus, by their survival, find themselves at the close of the campaign able to profit immediately by the improved conditions. A. C. G.

W. Heape. Emigration, Migration and Nomadism. W. Heffer and Sons, Ltd. Cambridge, 1931.

The late Mr. Walter Heape died in 1929, and the notes on which this book is based were originally intended to be part of a bigger work. Nevertheless, the subjects of Emigration and Migration are discussed exhaustively. The evidence available for each order of animals is set out under subheadings and the amount of data gathered is enormous. We find 249 titles in the Bibliography, and numerous other references to work not specifically mentioned.

His main thesis is the comparative physiology of the reproductive system, as this seems to underlie many of the phenomena of migration and emigration. Thus emigration, which, as distinct from migration, is a mass-movement involving no return and always ending in disaster, has its origin in a sudden catastrophic outburst of reproductive activity, accompanied by a hysteria, which drives its victims away from their overcrowded home to certain destruction.

Migrations, which involve a return of the migrants, are considered under the heads of climatic, alimental, and gametic migrations. Climatic and alimental migrations concern the welfare of the individual, and are the obvious response to the need for seeking the optimum climatic and alimental conditions available. But gametic migrations, as the author rightly stresses, are concerned with the welfare of the race, and often inflict great hardship on the individuals.

The author associates the impulse to the gametic migration with the first onset of activity in the gonads. This excitement is quite distinct from the sexual instinct, which sets in much later with the formation of the gametes. The direction in which the gametic migration will take place depends partly upon "racial memory" of the home of the race, partly upon the need of the individual to find food of a certain special quality to complete the development of its gonads and to supply the necessary growth vitamins to its young. This special quality of food is found in young growing vegetable life, whether on land or in the sea. The same consideration applies, to some extent, to alimental migrations.

Of the great number of examples of emigrations and migrations which he gives, we are here primarily interested in those drawn from fishes. Here the author has not been happy in his reading. He gives, as examples of emigrations, firstly, the well-known disaster to the tile-fish, *Lopholatilus chamaeleonticeps*, off the New England coast in 1882, and, secondly, the partial disappearance of the halibut from the banks off the American Pacific

coast. The former example is more generally regarded as due to a catastrophic change in the environment of the fish, not to a mass emigration away from their usual habitat. The partial disappearance of the halibut from the coast banks and their capture in deeper and deeper water is more probably due to the reduction of the stock, by overfishing of the easily accessible banks, to a level below that worth exploiting commercially, than to any change in the habits of the fish.

As to the migrations of fishes, the author's examples make strange reading. Thus the herring is described as a deep sea fish, which migrates, for breeding purposes, in huge shoals from the Atlantic, and even perhaps from the Arctic, to our east and west coasts, retiring afterwards to northern waters. During the winter they "hibernate in deep water, perhaps under the ice". This is surely the perpetuation of an archaic fable which recent herring research has shown to be untenable. The author quotes GRAHAM's earlier work on the migrations of the North Sea cod, and concludes that "it remains to be shown what happens to the bulk of the fish in the winter months". "I cannot claim that the fact is proved, but it does seem probable that they retire during the winter months to deep water in the north".

In these cases the author falls into the fallacy that, because a fish disappears from commercial catches, it has migrated elsewhere to inaccessible places. He forgets that a fishery depends upon concentrated shoals of fish. If we very reasonably assume that, after the spawning-migrations, when the fish are necessarily crowded together and therefore easily taken with the fishing-engines at present in use, the fish scatter in their nomadic feeding period, their disappearance will be equally well accounted for. The sea is a big place, and the same number of fish which give rise to an important fishery when they are concentrated, will yield only an occasional specimen when they are distributed over thousands of square miles, whether singly or in small shoals. Local concentrations of food, however, will naturally cause local concentrations of the feeding fish.

These examples, and many others, show that the author has not been fortunate in his reading in the literature of fishes. He is not to blame, for most of the recent results of fishery research are locked away in journals and monographs which rarely reach the general biologist. This is the more regrettable in the present case, as fishes are among the world's most interesting migrants. C. F. H.

Current Bibliography.

Prepared by the Editor with the assistance of Miss THURSBY-PELHAM.

NOTE. The scope of the Bibliography is limited in the main to the area covered by the Council's activities, but there are included papers of general interest relating to other areas in the North Temperate and Arctic regions and exceptionally elsewhere. Limnological references are not as a rule given, but papers relating to brackish waters and to salmon and freshwater fish studied by the Council are included.

The classification of entries follows in a general way that adopted in Dr. ALLEN's Selected Bibliography published in Vol. I, Nos. 1 and 2 of the Journal, and since reprinted (Price, 1 Kr.).

Subscribers and those on the distribution list will receive regularly upon application to the Administrative Secretary copies of the Bibliography printed on one side of the page only, for use in making up card indices.

The Editor will be glad to be advised of emendations and additions to the Bibliography.

Physical and Biological Conditions in the Sea.

GENERAL HYDROGRAPHY

BIGELOW, H. B. and ISELIN, C. Progress of the Woods Hole Oceanographic Institution and Cruises of the Atlantis. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 195—99, Washington, D. C. 1932.

BÖHNECKE, G., FØYN, B. und WATTENBERG, H. Beiträge zur Ozeanographie des Oberflächenwassers in der Dänemarkstrasse und Irminger See. II. Teil. Ann. der Hydrogr. und Marit. Meteor. LX, 314—21, 1932.

BORDEN, F. S. Oceanographic Work of the Coast and Geodetic Survey during the Past Year. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 211—24, Washington, D. C. 1932.

BRAARUD, T. and RUUD, J. T. The "Øst" Expedition to the Denmark Strait 1929. I. Hydrography. Hvalrådets Skrifter, Nr. 4, Oslo, 1932.

CHAPLIN, J. M. Narrative of Hydrographic Survey Operations in South Georgia and the South Shetland Islands, 1926—1930. Discovery Reports, III, 297—344, Cambridge, 1932.

CHAUCHARD, P. Sur les facteurs de variation du pouvoir réducteur de l'eau de mer. Comptes rendus de l'Académie des Sciences de Paris, 11 Avril 1932.

Defant, A. Die internationalen hydrographischen Untersuchungen im südlichen Kattegatt im August 1931. Forschgn. und Fortschr. 1932, Nr. 2.

Lettau, H. Über die Periode freier Schwingungen von unvollständig abgeschlossenen Wassermassen (Mündungskorrektion bei Seiches). Gerlands Beitr. z. Geophysik, XXXVII, 41—48, 1932.

McManus, A. B. Contributions of the United States Hydrographic Office to Oceanography. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 207—11, Washington, D. C. 1932.

Meissner, O. Der jährliche Gang des Mittelwassers der südlichen Ostseeküste im Lustrum 1926 bis 1930. Ann. der Hydrogr. und Marit. Meteor., LX, 342—44, 1932.

Norway. The Scientific Results of the Norwegian Arctic Expedition in the Gjøa 1903—1906, under the conduct of Roald Amundsen. Part I. Geofysiske Publikasjoner, Vol. VI, Oslo, 1932.

Ricketts, N. G. Oceanographic work of the United States Coast Guard during 1931 and Plans for 1932. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 252—53, Washington, D. C. 1932.

Riel, P. M. van. The Snellius Expedition. Journal du Conseil, VII, 212—17, 1932.

Schmidt, Johs. Dana's Togt omkring Jorden 1928—1930. København, 1932.

Sverdrup, H. U. Arbeider i luft- og havforskning. Beretn. fr. Chr. Michelsens Inst. f. Vidensk. etc. Bergen, Bd. II, 1932. (In Norwegian, English Résumé.)

Tait, J. B. The Liaison between the Sciences of Oceanography and Meteorology. VIIe Congrès International d'Aquiculture et de Pêche (Paris 1931), Groupe I, Section 2, Orléans, 1931.

Uda, M. Hydrographical Investigations in the Seas Adjacent to Wakasa Bay. Records Oceanogr. Works in Japan, IV, 1—29, Tokyo, 1932.

Vaughan, T. W. Oceanographic Work at the Scripps Institution of Oceanography University of California, La Jolla, California, July 1, 1931 to April 18, 1932. Nationa Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 200—06, Washington, D. C. 1932.

Wüst, G., Böhnecke, G. und Meyer, H. H. F. Ozeanographische Methoden und Instrumente. Wiss. Ergebnisse der Deutsch. Atlantischen Exped. auf dem Forschungs- und Vermessungsschiff "Meteor", 1925—1927, Band IV, Erster Teil, Berlin und Leipzig, 1932.

Physics and Chemistry of Sea Water.

Arakawa, H. The effect of the atmosphere on water waves. Geophys. Magazine, Tokyo, Vol. V, No. 1, 1932.

TEMPERATURE AND SALINITY

Alexander, W. B., Southgate, B. A. and Bassindale, R. The Salinity of the water retained in the Muddy Foreshore of an Estuary. Journ. Mar. Biol. Assoc., N. S. XVIII, 297—98, Plymouth, 1932.

Anon. Note on a Submarine Temperature Recorder by M. P. Idrac. Hydrographic Review, IX, No. 1, 235, Monaco, 1932.

Brooks, C. F. Sea-Temperatures by Bucket on Express Liners. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 258—63, Washington, D. C. 1932.

De Buen, R. El clima marino. Revista del Consejo Oceanogr. Ibero-Americano, Ano III, Núm. 2, 79—87, 1932.

Church, Ph. Surface Temperature of the Gulf Stream and its border waters. Geogr. Review, U. S. A. April 1932.

Church, P. E. Progress in the Investigation of Surface Temperatures of the Western North Atlantic. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 244—49, Washington, D. C. 1932.

Le Gall, J. L'Explication scientifique d'une observation pratique: La coupure d'août. La Pêche Maritime, la Pêche Fluviale et la Pisciculture, XV, 345—47, Août, 1932.

Hidaka, K. Über eine neue Korrekt'formel zur Umkippthermomet-Ablesung. Memoirs Imp. Mar. Observatory, Kobe, Vol. V, H. 1, 1932.

McDonald, W. F. Notes on the Exchange of Energy between ocean and atmosphere. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 131—36, Washington, D. C. 1932.

Möller, J. Temperaturmessung von Luft und Wasser auf dem Ozean und ihre Auswertung. Die Messtechnik, H. 4, 1932.

Reid, D. M. Salinity Interchange between Salt Water in Sand and Overflowing Fresh Water at Low Tide. II. Journ. Mar. Biol. Assoc., N. S. XVIII, 299—306, Plymouth, 1932.

Seiwell, H. R. Some Physical Characteristics of the water of Penobscot Bay, Maine, especially in relation to the Tides, and a discussion of the Results obtained by Duplicate Measurements of Specific Gravity of Sea Water by the Knudsen and Plummet Methods. Internationale Revue der gesamt. Hydrobiol. und Hydrogr., XXVII, 315—31, 1932.

Stephenson, E. B. Temperature Gradients in Ocean-Waters. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 238—43, Washington, D. C. 1932.

Stumpf, E. Ozeanographie zur Ausnutzung des Wärmegefälles im Meere. Mitt. d. Geogr. Ges., Wien, Bd. 75, Nr. 1—3.

HYDROGEN ION CONCENTRATION AND DISSOLVED GASES

Buch, K. und Gripenberg, S. Über den Einfluss des Wasserdruckes auf pH und das Kohlensäuregleichgewicht in grösseren Meerestiefen. Journal du Conseil, VII, 233—45, 1932.

Claude, G. Sur l'extraction des gas dissous dans le procédé Claude-Boucherot. Bull. de l'Inst. Océanogr., No. 601, Monaco, 1932.

Gee, H., Moberg, E. G., Greenberg, D. M. and Revelle, R. Calcium Equilibrium in Sea Water. Bull. Scripps Inst. Oceanography, La Jolla, California, Tech. Ser., III, 145—90, Berkeley, U. S. A. 1932.

Wattenberg, H. Liquid Carbon Dioxide in the Depths of the Ocean. Nature, CXXX, 26, 1932.

NITROGENOUS COMPOUNDS

Atkins, W. R. G. Nitrate in Sea-Water and its Estimation by means of Diphenylbenzidine. Journ. Mar. Biol. Assoc., N. S. XVIII, 167—92, Plymouth, 1932.

Cooper, L. H. N. The Determination of Nitrate in the Sea by Means of Reduced Strychnine. Journ. Mar. Biol. Assoc., N. S. XVIII, 161—6, Plymouth, 1932.

Soot-Ryen, T. Changes in the Nitrite Content through the Year in North-Norwegian Fjords. Journal du Conseil, VII, 246—50, 1932.

PHOSPHATES AND NITRATES

Rakestraw, N. W. Phosphorus and Nitrogen in the Neritic Waters of the Gulf of Maine. Internat. Rev. der gesamt. Hydrobiol. und Hydrogr. XXVII, 151—60, 1932.

OTHER CONSTITUENTS

Atkins, W. R. G. The Copper Content of Sea-Water. Journ. Mar. Biol. Assoc., N. S. XVIII, 193—98, Plymouth, 1932.

Gee, H., Moberg, E. G., Greenberg, D. M. and Revelle, R. Calcium Equilibrium in Sea Water. Bull. Scripps Inst. Oceanography, La Jolla, California, Tech. Ser., III, 145—90, Berkeley, U. S. A. 1932.

Piggott, C. S. Radium-Content of Ocean-Bottom Sediments. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 233—38, Washington, D. C. 1932.

Currents.

Ekman, V. W. Studien zur Dynamik der Meeresströmungen. Gerlands Beiträge z. Geophysik, XXXVI, 385—438, 1932.

Ekman, V. W. and Helland-Hansen, B. Measurement of Ocean Currents. K. Fysiograf. Sällskap. i Lund Förhandl., Band I, Nr. 1, 1932.

England. Current Meter Work. Min. of Agriculture and Fisheries, Fisheries Notice No. 17, London, 1932.

Lüders, K. Eichung des Richtungsanzeigers in einem Schwimmflügel für Strommessungen im Tidengebiet. Die Bautechnik, H. 6 u. 9, 1932.

LUMBY, J. R. Current Systems of the North Atlantic and the North Sea. Journ. Ecology, XX, 314—25, 1932.

NOMITSU, J. and TAKEGAMI, T. On the Convection Current and the Surface Level of a Two-layer Ocean. Mem. College Science, Kyoto Imp. Univ., Ser. A, XV, No. 3, 131—49, Kyoto, Japan, 1932.

SCHÄTZLER, —. Strömungsmessungen im Mündungsgebiet der Elbe. Die Bautechnik, H. 32, 1931.

SCHUBERT, O. VON. Die Strommessungen Pillsburys in moderner Bearbeitung. Ann. der Hydrogr. und Marit. Meteor. LX, Heft 9, 378—85, 1932.

SIGEMATU, R. Some Oceanographical Investigation of the Results of Oceanic Survey carried out by H. I. J. M. S. Mansyû from April 1925 to March 1928. Records Oceanogr. Works in Japan, IV, 151—70, Tokyo, 1932.

SMITH, E. H. The Recommendation of a program of hydrographical observations leading to the quantitative determination of Arctic and Atlantic interchanges. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 249—52, Washington, D. C. 1932.

SOKOLOW, A. Dynamic Chart of the Barents Sea. Trans. Oceanogr. Inst., II, No. 2, 59—82, Moscow, 1932. (In Russian, English Résumé.)

SPIESS, F. Mooring of Ships in deep water for the direct measurement of currents. Hydrographic Review, IX, No. 1, 7—38, Monaco, 1932.

SUDA, K. On the Dissipations of Energy in the Density Current. Geophys. Mag. Vol. VI, No. 3, 297—314, Central Meteor. Observ., Tokyo, Japan, 1932.

WITTING, R. A Current Meter, its Use and some Results. Journal du Conseil, VII, 218—32, 1932.

TIDES

ADMIRALTY. The Admiralty Tide Tables, Part I, for the Year 1933. Standard Edition. London, 1932.

ADMIRALTY. The Admiralty Tide Tables, Part I, for the Year 1933. Abridged Edition. London, 1932.

ANON. Recording Tide-Gauge with distant recorder — Rauschelbach System. Hydrographical Review, IX, No. 1, 224—25, Monaco, 1932.

ANON. Vocabulary concerning tides. Internat. Hydrogr. Bureau, Monaco. Spec. Public. Nr. 28. 1932.

CHAPMAN, S. On the Theory of the Lunar Tidal Variation of Atmospheric Temperature. Mem. Roy. Meteor. Soc., Vol. IV, No. 34, 1932.

DOODSON, A. T. and CORKAN, R. H. The Principal Constituent of the Tides in the English and Irish Channels. Phil. Trans. Roy. Soc., Ser. A, Vol. 231, No. A. 695, 1932.

MUKAI, M. On the seiches of a frozen lake, and the motion of the ice-plate. Proc. Phys.-Math. Soc. Tokio, March, 1932.

NOMITSU, T. Note on Dr. Rosenhead's Papers: "The Annual Variation of Latitude" and "Tides on a Two-layer Earth". Mem. College Science, Kyoto Imp. Univ., Series A, XV, No. 3, 123—29, Kyoto, Japan, 1932.

RAUSCHELBACH, H. Begriffsbestimmungen von Bezeichnungen zur Beschreibung und Berechnung der Gezeitenerscheinungen des Meeres. Ann. der Hydrogr. und Marit. Meteor. LX, 265—72, 1932.

SEIWELL, H. R. Some Physical Characteristics of the water of Penobscot Bay, Maine, especially in relation to the Tides, and a discussion of the Results obtained by Duplicate Measurements of Specific Gravity of Sea Water by the Knudsen and Plummet Methods. Internationale Revue der gesamt. Hydrobiol. und Hydrogr., XXVII, 315—31, 1932.

WIND

PALMÉN, E. Über die Einwirkung des Windes auf die Neigung der Meeresoberfläche. Soc. Scient. Fennica, Comm. Phys.-Math. VI, 14, Helsingfors, 1932.

STANTON, T., MARSHALL, D. and HOUGHTON, R. The Growth of Waves on Water due to the Action of the Wind. Proc. Roy. Soc., Ser. A, Vol. 137, 283—93, 1932.

LIGHT, COLOUR AND TRANSPARENCY

ATKINS, W. R. G. Solar Radiation and its Transmission through Air and Water. Journal du Conseil, VII, 171—211, 1932.

Hulburt, E. O. On the Penetration of Daylight into the Sea. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 224, Washington, D. C. 1932.

Richardson, B. Photoelectric measurements (made during the summer of 1930) of the Penetration of Light (Wave length 2,900 to 4,800 Ångström units) in sea-water, and the results of laboratory photoelectric measurements (made during the summer of 1931) of the absorption coefficient of sea-water. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 225, Washington, D. C. 1932.

Oceanography-Miscellaneous.

Anon. The Dana Expedition of 1928—30. Nature, CXXIX, 889—92, 1932.

Brooks, C. F. A Recent Tour of some Oceanographic Centers of Northwest Europe. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 253—58, Washington, D. C. 1932.

Bucher, W. H. Problems of Island Arcs and Ocean-Deeps. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 12—18, Washington, D. C. 1932.

Collin, M. L. Les vallées sous-marines de la côte nord du Finistère. Bull. de la Soc. d'Océanogr. de France, XII, 1178—82, 1932.

Drygalski, E. v. Deutsche Südpolar-Expedition, 1901—03. Forschgn. u. Fortschr. Nr. 12, 1932.

Haeberlin, C. und Perlewitz, P. Klima-Atlas für die Meeresheilkunde an der deutschen Seeküste. Hamburg, 1932.

Heck, N. H. Seismic Zones as related to Relief of Ocean-Bottom. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 21—26, Washington, D. C. 1932.

Heck, N. H. Seismology and the Ocean Basins. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 91—94, Washington, D. C. 1932.

Jensen, Aage J. C. Hydrographical Investigations of the Pollution of the Sound at Copenhagen. Report Danish Biological Stat., XXXVII, 21—34, Copenhagen, 1932.

Littlehales, G. W. Sounding the Depths of the Ocean for mapping the Conformation and Topography of the Bottom. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April, 1932, 33—37, Washington, D. C. 1932.

Riel, P. M. van. The Snellius Expedition. Journal du Conseil, VII, 212—17, 1932.

Shepard, F. P. Landslide Modifications of Submarine Valleys. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 226—30, Washington, 1932.

Taylor, H. F. Resources of the Ocean. Journ. of the Franklin-Inst. August, 1932.

Various. Physics of the Earth — V. Oceanography. Bull. National Research Council, No. 85, Washington, D. C., U. S. A. 1932.

Plankton.

Barnard, K. H. Amphipoda. Discovery Reports, V, 1—326, Cambridge, 1932.

Böhnecke, G., Føyn, B. und Wattenberg, H. Beiträge zur Ozeanographie des Oberflächenwassers in der Dänemarkstrasse und Irminger See. II. Teil. Ann. der Hydrogr. und Marit. Meteor. LX, 314—21, 1932.

Kokubo, S. Quantitative Studies on Microplankton in Aomori Bay during 1929—1930. Records Oceanogr. Works in Japan, IV, 171—244, Tokyo, 1932.

Lebour, M. V. The Larval Stages of *Simnia patula*. Journ. Mar. Biol. Assoc., N.S. XVIII, 107—16, Plymouth, 1932.

Lebour, M. V. The Eggs and early Larvae of Two Commensal Gastropods *Stilifer stylifer* and *Odostomia eulimoides*. Journ. Mar. Biol. Assoc., N. S. XVIII, 117—22, Plymouth, 1932.

Lebour, M. V. *Limacina retroversa* in Plymouth Waters. Journ. Mar. Biol. Assoc., N. S. XVIII, 123—30, Plymouth, 1932.

Lebour, M. V. The Larvae of the Plymouth Caridea. III. The Larval Stages of *Spirontocaris cranchii* (Leach). Proc. Zool. Soc. London, 1932, Part I, 131—38, 1932.

Lebour, M. V. The Larval Stages of the Plymouth Caridea. IV. The Alpheidae. Proc. Zool. Soc. London, 1932, Part II, 463—69, 1932.

Leloup, E. L'Eudoxie d'un Siphonophore Calycophoride rare, le *Nectopyramis thetis* Bigelow. Bull. du Musée Roy. d'Hist. Nat. de Belgique, VIII, No. 3, Bruxelles, 1931.

Ottestad, P. On the Biology of some Southern Copepoda. Hvalrådets Skrifter, Nr. 5, Oslo, 1932.

Runnström, S. Eine Übersicht über das Zooplankton des Herdla- und Hjeltefjordes. Bergens Museums Årbok, 1931, 2. Hefte, Naturvid. rekke Nr. 7, Bergen, 1932.

Russell, F. S. On the Biology of Sagitta. The Breeding and Growth of *Sagitta elegans* Verrill in the Plymouth Area, 1930—1931. II. The Breeding and Growth of *Sagitta setosa* J. Müller in the Plymouth Area, 1930—1931, with a comparison with that of *S. elegans* Verrill. Journ. Mar. Biol. Assoc., N. S. XVIII, 131—60, Plymouth, 1932.

Savage, R. E. Phaeocystis and Herring Shoals. Journ. Ecology, XX, 326—40, 1932.

Schuurmans Stekhoven, J. H. and Adam, W. The Freeliving Marine Nemas (Nematodes) of the Belgian Coast. Mém. du Musée Roy. d'Hist. Nat. de Belgique, Mém. No. 49, Bruxelles, 1931.

Tattersall, W. M. Contributions to a Knowledge of the Mysidacea of California. I. On a collection of Mysidae from La Jolla, California. II. The Mysidacea collected during the Survey of San Francisco Bay by the U. S. S. "Albatross" in 1914. Univ. Calif. Public. in Zool., Vol. 37, 301—47, Berkeley, U. S. A. 1932.

Wilson, D. P. The Development of *Nereis pelagica* Linnaeus. Journ. Mar. Biol. Assoc., N. S. XVIII, 203—18, Plymouth, 1932.

Marine Bacteria.

Butkewitsch, W. S. Methodik der bakteriologischen Meeresuntersuchungen und einige Angaben über die Verteilung der Bakterien im Wasser und in den Böden des Barents Meeres. Trans. Oceanogr. Inst., Band II, No. 2, 5—39, Moscow, 1932. (In Russian, German Résumé.)

Field, R. M. Microbiology and the Marine Limestone. National Research Council, Trans. Amer. Geophys. Union, 13th Ann. Meet., 28th and 29th April 1932, 230—33, Washington, D. C., 1932.

Gee, H. Bacteriological Water Sampler. Bull. Scripps Inst., Oceanography, La Jolla, California, Tech. Ser., III, 191—200, Berkeley, U. S. A. 1932.

Marine Algae.

Okamura, K. The Distribution of Marine Algae in Pacific Waters. Records Oceanogr. Works in Japan, IV, 30—150, Tokyo, 1932.

Bottom Deposits.

Pratje, O. Einwirkung der Wassereigenschaften an den Ablagerungen in der Deutschen Bucht. Forschgn. u. Fortschr. 1932, Nr. 16.

Smith, J. E. The Shell Gravel Deposits and the Infauna of the Eddystone Grounds. Journ. Mar. Biol. Assoc., N. S. XVIII, 243—78, Plymouth, 1932.

Bottom Fauna.

GENERAL

Blegvad, H. Investigations of the Bottom Fauna at Outfalls of Drains in the Sound. Report Danish Biol. Stat., XXXVII, 1—20, Copenhagen, 1932.

Brotzky, V. and Zenkewitch, L. Materials for the quantitative evaluation of the bottom fauna of the Barents, White and Kara Seas. No. 6. A quantitative evaluation of the bottom fauna of the Cheshskay Bay. Trans. Oceanogr. Inst., Band II, No. 2, 41—57, Moscow, 1932. (In Russian, English Résumé.)

Pirrie, M. E., Bruce, J. R. and Moore, H. B. A Quantitative Study of the Fauna of the Sandy Beach at Port Erin. Journ. Mar. Biol. Assoc., N. S. XVIII, 279—96, Plymouth, 1932.

Smith, J. E. The Shell Gravel Deposits and the Infauna of the Eddystone Grounds. Journ. Mar. Biol. Assoc., N. S. XVIII, 243—78, Plymouth, 1932.

PHYSIOLOGY AND BEHAVIOUR

Carter, G. S. Iodine Compounds and Fertilization. II. The Oxygen Consumption of Suspensions of Sperm of *Echinus esculentus* and *Echinus miliaris*. III. The Fertilizable Life of the Eggs of *Echinus esculentus* and *Echinus miliaris*. Journ. Exper. Biol. VIII, No. 2, 176—201, 1931.

Cunningham, J. T. Selection and Growth in Shore Crabs. Nature, CXXX, 476, 1932.

Graham, A. On the Structure and Function of the Alimentary Canal of the Limpet. Trans. Roy. Soc. Edinburgh, LVII, 287—308, 1932.

Schreiber, B. Pigmenti e secrezioni nel sistema digerente delle oloturie. Pubbl. della Staz. Zool. di Napoli, XII, 18—60, Roma, 1932.

Schreiber, G. Ricerche sui pigmenti delle Aplisie. Pubbl. della Staz. Zool. di Napoli, XII, 291—321, Roma, 1932.

Sereni, E. and Young, J. Z. Nervous degeneration and regeneration in Cephalopods. Pubbl. della Staz. Zool. di Napoli, XII, 173—208, Roma, 1932.

Sexton, E. W. Degeneration and Loss of the Eye in the Amphipod *Gammarus chevreuxi* Sexton, Part I. Journ. Mar. Biol. Assoc., N. S. XVIII, 355—96, Plymouth, 1932.

Spooner, G. M. An Experiment on Breeding Wild Pairs of *Gammarus chevreuxi* at a High Temperature, with an account of Two New Recessive Types of Red Eye. Journ. Mar. Biol. Assoc., N. S. XVIII, 337—54, Plymouth, 1932.

Yonge, C. M. On the Nature and Permeability of Chitin. I. The Chitin lining the Foregut of Decapod Crustacea and the Function of the Tegumental Glands. Proc. Roy. Soc., Series B, Vol. 111, 298—29, 1932.

SPECIAL GROUPS

Barnard, K. H. Amphipoda. Discovery Reports, V, 1—326, Cambridge, 1932.

Bull, H. O. Note on an unusual specimen of *Asterias rubens*. Journ. Mar. Biol. Assoc., N. S. XVIII, 225—28, Plymouth, 1932.

Dollfus, R. Ph. Sur l'Attaque de la coquille des Bigorneaux, *Littorina littorea* (L.), de Hollande, par Polydora. Rev. des Trav. de l'Office des Pêches Marit., V, 273—77, 1932.

Heron-Allen, E. and Earland, A. Foraminifera. Part I. The Ice-free Area of the Falkland Islands and Adjacent Seas. Discovery Reports, IV, 291—460, Cambridge, 1932.

Lacroix, E. Discammina: nouveau genre méditerranéen de Foraminifères arénacés. Bull. de l'Inst. Océanogr., No. 600, Monaco, 1932.

Leloup, E. Contributions à l'étude de la Faune Belge. I. L'hydraire, *Campanulina hincksi* Hartlaub. Bull. du Musée Roy. d'Hist. Nat. de Belgique, VIII, No. 2, Bruxelles, 1932.

Leloup, E. Cerianthaires de l'Océan Atlantique. Bull. du Musée Roy. d'Hist. Nat. de Belgique, VIII, No. 4, Bruxelles, 1932.

Leloup, E. L'homologie des parties constituantes du gonosome chez *Theocarpus* et *Aglaophenia* et la Classification des Aglaopheniidae. Bull. du Musée Roy. d'Hist. Nat. de Belgique, VIII, No. 1, Bruxelles, 1932.

Moore, H. B. The Faecal Pellets of the Trochidae. Journ. Mar. Biol. Assoc., N. S XVIII, 235—42, Plymouth, 1932.

Moore, H. B. A Hermaphrodite Sea-Urchin. Nature, CXXX, 59, 1932.

Moore, H. B. The Faecal Pellets of the Anomura. Proc. Roy. Soc. Edinburgh, LII, Part III, 296—308, 1932.

Neu, W. Das Vorkommen von *Balanus improvisus* Darwin auf Helgoländer Seetonnen. Zool. Anz. XCIX, 143—49, 1932.

Prenant, M. Sur une collection de Bryozoaires de la Mer du Nord appartenant au Musée Royal d'Histoire Naturelle de Belgique. Bull. du Musée Roy. d'Hist. Nat. de Belgique, VII, No. 17, Bruxelles, 1931.

Pruvot-Fol, A. Notes de systématique sur les Opisthobranches. Bull. du Muséum Nation. d'Hist. Nat., 2e Série, IV, 322—31, Paris, 1932.
Rawlinson, R. Specific Differences in the Gonadial spicules of *Echinus esculentus* (Linnaeus) and *Psammechinus miliaris* (Gmelin). Journ. Mar. Biol. Assoc., N. S. XVIII, 229—34, Plymouth, 1932.
Schuurmans Stekhoven, J. H. und Coninck, L. de. Zur Synonymie von *Ascolaimus elongatus* (Bütschli). Zool. Anz. XCIX, 149—63, 1932.
Schuurmans Stekhoven, J. H. and Adam, W. The Freeliving Marine Nemas (Nematodes) of the Belgian Coast. Mém. du Musée Roy. d'Hist. Nat. de Belgique, Mém. No. 49, Bruxelles, 1931.
Sexton, E. W., Clark, A. R. and Spooner, G. M. Some new Eye-Colour Changes in *Gammarus chevreuxi* Sexton. Part II. Journ. Mar. Biol. Assoc., N. S. XVIII, 307—36, Plymouth, 1932.
Spärck, R. On the Capacity of Migration of Adult Individuals of *Asterias rubens*. Report Danish Biol. Stat., XXXVII, 65—68, Copenhagen, 1932.
Yonge, C. M. A Note on *Balanophyllia regia*, the only Eupsammid Coral in the British Fauna. Journ. Mar. Biol. Assoc., N. S. XVIII, 219—24, Plymouth, 1932.

Fishery Investigations.

GENERAL

Anon. Lancashire and Western Sea Fisheries. Fishing News, 21, 11—VI—32.
Fischer, E. Die wichtigste Fischereiliteratur aus dem Jahre 1931. A. Seefischerei. Jahresbericht über die Deutsche Fischerei, 1931, 277—82, Berlin, 1932.
Messjazeff, I. I. Die Arbeiten zur Erforschung der Küstenfischerei am Murman im Jahre 1930 und ihre Ergebnisse. Reports 1st Session of the State Oceanogr. Inst., Moscow, (April 14—22, 1931), No. 3. (In Russian, German Résumé.)
Scotland. Fiftieth Annual Report of the Fishery Board for Scotland, being for the year 1931. Edinburgh, 1932.

COMMERCIAL FISHERIES

Anon. Fishermen and Fisheries of Faroe. Fishing News, 24, 30—VII—32.
Blegvad, H. On Aerial Spotting of Fish Shoals. II. Danish Experiments in 1931. Report Danish Biol. Stat., XXXVII, 75—82, Copenhagen, 1932.
Brunelli, G. Gli Studie sull'alimentazione ittica per il maggior consumo dei prodotti della pesca. Boll. di Pesca, di Piscicolt. e di Idrobiol. VIII, 11—23, Roma, 1932.
Eichelbaum, E. Die Seefischerei. Jahresbericht über die Deutsche Fischerei, 1931, 5—112, Berlin, 1932.
England. Report on Sea Fisheries for the Year 1931. Ministry of Agriculture and Fisheries, London, 1932.
Explorer. Are the North Sea Fisheries Played Out? Fishing News, 52—53, 11—VI—32.
Fischer, E. Die Küstenfischerei und Kutter-Hochseefischerei. Jahresbericht über die Deutsche Fischerei, 1931, 168—83, Berlin, 1932.
Italy. La Pesca nei Mari e nelle Acque Interne d'Italia. Volume Terzo. Ministerio dell'Agricoltura e delle Foreste, Roma, 1931.
Neumann, J. Die deutsche Hochseefischerei. Jahresbericht über die Deutsche Fischerei, 1931, 153—63, Berlin, 1932.
Norway. Beretninger om torskefisket (utenom Lofoten) og silde, makrell-, bank- og kveitefisket samt selfangsten i 1930. Årsberetning vedkom. Norges Fiskerier, 1930, Nr. IV, Bergen, 1932.
Orru, A. Sul valore biologico alimentare delle proteine contenute nella carne di *Mugil cephalus* Cuv. Boll. di Pesca, di Piscicolt. e di Idrobiol., VIII, 24—28, Roma, 1932.
Roule, L. Manuel de Pisciculture. Encyclopédie des Connaissances Agricoles. Hachette, Paris, 1932.
Santarelli, M. La Pesca del polpo (*Octopus vulgaris*) nel Golfo di Napoli. Bull. de l'Inst. Océanogr., No. 597, Monaco, 1932.
Stassano, E. La pesca sulle spiagge atlantiche del Sahara. Boll. di Pesca, di Piscicolt. e di Idrobiol., VIII, 219—65, Roma, 1932.

Fishes.

GENERAL

Anon. Omologazione internazionale dei nomi delle Specie marine utili all'alimentazione. Germania. Boll. di Pesca, di Piscicolt. e di Idrobiol., VIII, 59—61, Roma, 1932.

De Buen, F. Formas Ontogenicas de Peces (Nota Primera). Notas y Resúmenes, Serie II, Núm. 57, Madrid, 1932.

Desbrosses, P. La Dorade Commune (*Pagellus centrodontus* Delaroche) et sa pêche. (Répartition, importance et fluctuations des apports, lieux de pêche, migrations saisonnières et leurs causes). Rev. des Travaux de l'Office des Pêches Marit. V, 167—222, 1932.

Gudger, E. W. The Abundance of the Dolphins, *Coryphaena hippurus*, on the North Carolina coast. Journ. Elisha Mitchell Scient. Soc., Vol. 47, 237—44, U. S. A. 1932.

Joubin, L. Faune Ichthyologique de l'Atlantique Nord, Nos. 9 et 10. Cons. Perm. Int. pour l'Explor. de la Mer, Copenhague, 1932.

Koefoed, E. Fishes from the Sea-Bottom. Rep. Scient. Results "Michael Sars" North Atlantic Deep-Sea Exped. 1910, Vol. IV, Part I, Bergen, 1932.

Norman, J. R. Note on a Shark, *Oxynotus paradoxus* Frade, new to the British Fauna. Proc. Zool. Soc. London, 1932, Part I, 77—80, 1932.

Parr, A. E. A study of subspecies and racial variations in *Liparis liparis* Linneus and *Liparis koefoedi*, n. sp., in Northern Europe and the European Arctic Waters. Bergens Museums Årbok, 1931, 2. Hefte, Naturvid. rekke Nr. 6, Bergen, 1932.

Vinciguerra, D. Intorno ad alcune specie di pesci raccolti dal Dott. Enrico Stassano presso la costa occidentale del Sahara. Boll. di Pesca, di Piscicolt. e di Idrobiol., VIII, 266—304, Roma, 1932.

PHYSIOLOGY AND BEHAVIOUR

Evans, H. M. Further Observations on the *Medulla oblongata* of Cyprinoids; and a comparative study of the Medulla of Clupeoids and Cyprinoids with special reference to the acoustic tubercles. Proc. Roy. Soc., Ser. B, Vol. 111, 247—80, 1932.

Gray, J. The Osmotic Properties of the Eggs of the Trout (*Salmo fario*). Journ. Exper. Biol. IX, 277—99, 1932.

Harris, H. A. Cod Liver Oil and the Vitamins in Relation to Bone Growth and Rickets. Amer. Journ. Medical Sciences, CLXXXI, 453—78, 1931. (Periodic structures in bones and scales.)

Kempf, G. und Neu, W. Schleppversuche mit Hechten zur Messung des Wasserwiderstandes. Zeitschr. f. vergl. Physiol. XVII, 353—64, 1932.

Klenk, F. Untersuchungen über Geschmackswirkung von Säuren bei Fischen mit einem Vergleich am Menschen. Zeitschr. f. vergl. Physiol. XIII, 359—96, 1930.

Maes, R. La vision des formes chez les poissons. Ann. Soc. Zool. de Belgique, LX, 103—29, 1929.

Raffy, A. Recherches physiologiques sur le mécanisme de la mort des Poissons sténohalins soumis à des variations de Salinité. Bull. de l'Inst. Océanogr., No. 602, Monaco, 1932.

Ranzi, S. Le basi fisio-morfologiche dello sviluppo embrionale dei Selaci. Parte I. Pubbl. della Staz. Zool. di Napoli, XII, 209—90, Roma, 1932.

Russell, E. S. and Bull, H. O. A selected Bibliography of Fish Behaviour. Journal du Conseil, VII, 255—83, 1932.

Scharrer, E. Die Sekretproduktion im Zwischenhirn einiger Fische. (Untersuchungen über das Zwischenhirn der Fische III.) Zeitschr. f. vergleich. Physiol., XVII, 491—509, 1932.

Sereni, E. Sulla presenza di ormone femminile nelle uova dei Pesci. Pubbl. della Staz. Zool. di Napoli, XII, 145—72, Roma, 1932.

Werner, C. F. Die Erforschung der nichtakustischen Funktionen des Labyrinthes bei Fischen, und Zyklostomen. Handbuch der biologischen Arbeitsmethoden (Abderhalden), Abt. V, Teil 7, Heft 8, 1039—78, Berlin, 1932.

Wood, A. H. The Effect of Temperature on the Growth and Respiration of Fish Embryos (*Salmo fario*). Journ. Exper. Biol. IX, 271—76, 1932.

Wunder, W. Wie fangen planktonfressende Fische ihre Nahrungstiere? Versuche an Karpfen. Zeitschr. f. vergl. Physiol. XVII, 304—36, 1932.

Wunder, W. Nestbau und Brutpflege bei Fischen. Ergebn. Biol. VII, 1931.

EGGS AND LARVAE

ROULE, L. L'hypermétamorphose larvaire chez les poissons. Revue Scientifique, No. 11, Juin, 1932.

SPARTA, A. Contributo alla conoscenza di uova e larve nei Labridi. III. Uova e larve di *Crenilabrus massa* Risso, ottenute da fecondazione artificiale. R. Com. Talassogr. Ital., Mem. CXCI, Venezia, 1932.

FISH PARASITES AND DISEASES

DOGIEL, V. Eine neue in Acipenseriden parasitierende Nematodengattung aus der Familie Acuariidae. Zool. Anz. XCIX, 263—69, 1932.

LELOUP, E. Un cas d'épibiose de l'Hydropolype *Laomedea geniculata* (Linné). Bull. du Musée Roy. d'Hist. Nat. de Belgique, VII, No. 24, Bruxelles, 1931.

PINTNER, J. Sinnespapillen am Genitalatrium der Tetrarhynchen. Zool. Anz. XCVIII, 295—98, 1932.

STEWART, M. M. The Bacterial Flora of the Slime and Intestinal Contents of the Haddock (*Gadus aeglefinus*). Journ. Mar. Biol. Assoc., N. S. XVIII, 35—50 Plymouth, 1932.

AQUARIUM EQUIPMENT AND MANAGEMENT

BREDER, C. M. and SMITH, H. W. On the Use of Sodium Bicarbonate and Calcium in the Rectification of Sea-water in Aquaria. Journ. Mar. Biol. Assoc., N. S. XVIII, 199—200, Plymouth, 1932.

COOPER, L. H. N. On the Effect of Long Continued Additions of Lime to Aquarium Sea-water. Journ. Mar. Biol. Assoc., N. S. XVIII, 201—02, Plymouth, 1932.

PLAICE AND OTHER PLEURONECTIDS

BERG, L. S. Revision des formes de *Pleuronectes flesus*. Notas y Resúmenes, Serie II, No. 58, Madrid, 1932.

BLEGVAD, H. On the Flounder (*Pleuronectes flesus* L.) and the Danish Flounder Fishery in the Baltic. Cons. Perm. Int. pour l'Explor. de la Mer, Rapp. et Proc.-Verb. LXXVIII, I, 1—28, Copenhague, 1932.

BLEGVAD, H. Preliminary Report on the Danish Experimental Transplantations of Plaice from the North Sea to the Belt Sea during the Years 1928—31. Report Danish Biol. Stat., XXXVII, 83—94, Copenhagen, 1932.

BÜCKMANN, A. Die gegenwärtige Lage der Schollenfischerei in der Nordsee. Der Fischerbote, XXIV, 147—53, 1932.

FISCHER, E. Ist die Einführung einer Schonzeit für die Flunder der Ostsee erforderlich? Cons. Perm. Int. pour l'Explor. de la Mer, Rapp. et Proc.-Verb. LXXVIII, IV, 1—12, Copenhague, 1932.

JÄRVI, T. H. Die Flundernfischerei in Finnland. Cons. Perm. Int. pour l'Explor. de la Mer, Rapp. et Proc.-Verb. LXXVIII, II, 1—5, Copenhague, 1932.

JENSEN, AAGE J. C. Rødspættefiskeriet i Nordsøen. Dansk Fiskeritidende, Nr. 37, 465—68, 1932.

KÄNDLER, R. Veränderungen im Flundernbestand der Ostsee durch die Fischerei. Cons. Perm. Int. pour l'Explor. de la Mer, Rapp. et Proc.-Verb. LXXVIII, III, 1—45, Copenhague, 1932.

LAURINAT, K. Aussetzung und Wiederfang von in der mittleren und westlichen Ostsee markierten Klieschen. Mitt. des Deutsch. Seefisch.-Ver. XXXXVIII, 75—87 1932.

MOLANDER, A. R. Der Flunderbestand in der südlichen Ostsee und der Einfluss, den die Fischerei auf ihn ausübt. Cons. Perm. Int. pour l'Explor. de la Mer, Rapp. et Proc.-Verb. LXXVIII, V, 1—15, Copenhague, 1932.

N. R. Kan rödspättebeståndet i Östersjön förbättras genom utkläckning av rom? Ny Svensk Fiskeritidskrift, Nr. 16, 184—85, 1932.

POULSEN, E. M. Analyses of Stock and Race of the Baltic Plaice during Recent Years. Report Danish Biol. Stat. XXXVII, 35—58, Copenhagen, 1932.

THURSBY-PELHAM, D. E. The Present Position of the Steam Trawler Plaice Fishery at Lowestoft. Fishing News, 26—27, 25—VI—32.

COD

Dementjewa, T. F., Pletschkowa, E. K., Rosanowa, M. I. und Tanassijtschuk, W. S. Rassenuntersuchungen am Barentssee-Kabeljau. Reports of the First Session of the State Oceanogr. Inst. (14—22 April 1931) No. 2, 49—78, Moscow, 1932. (In Russian, German Résumé.)

HADDOCK

McKenzie, R. A. Water Temperature and the Haddock Fishery of the Fundy Area. Progress Reports, Atlantic Biol. Stat., St. Andrew's N. B., and Fisheries Experimental Stat. (Atlantic) Halifax, N. S., 10—13, July, 1932.

Messjatzeff, I. I. Die Arbeiten zur Erforschung der Küstenfischerei am Murman im Jahre 1930 und ihre Ergebnisse. Reports 1st Session of the State Oceanogr. Inst., Moscow, (April 14—22, 1931), No. 3. (In Russian, German Résumé.)

HAKE

Hickling, C. F. Hake Marking Experiments. Fishing News, 17, 20—VIII—32.

TUNNY

Back, A. et Legendre, R. L'état sexuel du Germon pendant la saison de pêche. Comptes rendus à l'Académie des Sciences, Séance du 25 Avril 1932.

Le Gall, J. L'Explication scientifique d'une observation pratique: La coupure d'août. La Pêche Maritime, la Pêche Fluviale et la Pisciculture, XV, 345—47, Août, 1932.

Heldt, H. Observations aériennes pour le repérage des bancs de thons et possibilité de l'étude directe de leurs migrations. Comptes Rendus, Académie des Sciences, Paris, 27 Juin 1932.

Sanzo, L. Uova e primi stadi larvali di Tonno (*Orcynus thynnus* Ltkn.). R. Com. Talassogr. Ital., Mem. CLXXXIX, Venezia, 1932.

Wolfe Murray, D. K. Tunny (*Thunnus thynnus* L.) in the North Sea. Journal du Conseil, VII, 251—54, 1932.

HERRING

Le Gall, J. Statistiques biologiques et considérations sur la population harenguière du Klondyke et du Nord de l'Irlande. Rev. des Trav. de l'Office des Pêches Marit. V, 123—39, 1932.

Hodgson, W. C. Forecast of East Anglian Herring Fishery. Fishing News, 22—23 20—VIII—32.

Rounsefell, G. A. and Dahlgren, E. H. Fluctuations in the Supply of Herrings, *Clupea pallasii* in Prince William Sound, Alaska. Bull. Bureau of Fisheries, XLVII, 263—91, U. S. A. 1932.

Savage, R. E. *Phaeocystis* and Herring Shoals. Journ. Ecology, XX, 326—40, 1932,

Steffen, W. Die grosse Heringsfischerei. Jahresbericht über die Deutsche Fischerei. 1931, 164—67, Berlin, 1932.

PILCHARD, SPRAT AND ANCHOVY

Belloc, G. Contribution à l'étude de la Sardine des côtes françaises de l'Atlantique, (entre Loire et Gironde). Rev. des Trav. de l'Office des Pêches Marit. V, 141—66, 1932.

Hart, J. L. and Wailes, H. The Food of the Pilchard. Report of the Commissioner of Fisheries for the year ended the 31st Dec. 1931, with Appendices, 49—57, Prov. Brit. Columbia, Victoria, 1932.

Navarro, F. de P. Nuevos Estudios sobre la Alacha (*Sardinella aurita* C. & V.) de Baleares y de Canarias. Notas y Resúmenes, Serie II, Núm. 60, Madrid, 1932.

MACKEREL

Jensen, Aage J. C. Udsigterne for Makrelfiskeriets Udbytte i Sundet i Efteraaret 1932. Dansk Fiskeritidende, Nr. 22, 277—78, 1932.

GURNARD

Priol, E. Remarques sur les espèces de grondins les plus communes des côtes de France. Rev. des Trav. de l'Office des Pêches Marit. V, 223—72, 1932.

EELS

Anon. The Dana Expedition of 1928—30. Nature, CXXIX, 889—92, 1932.

Gandolfi-Hornyold, A. Mensurations de deux pêches de civelles de Saint-Nazaire et d'Aguinaga. Bull. de la Soc. Centrale d'Aquiculture et de Pêche, XXXIX, Nos. 7—9, 74—78, 1932.

Lundbeck, J. Ricerche sul danneggiamento dei pesci specialmente delle anguille nelle turbine dell'officina d'energia elettrica di Friedland (Prussia dell'Est). Boll. di Pesca, di Piscicolt. e di Idrobiol., VIII, 31—58, Roma, 1932.

Schmidt, Johs. 25 Jahre dänische Aaluntersuchungen (1905—1930). Natur und Museum, LXII, Heft 7, 213—228, Frankfurt a. M. 1932.

Schmidt, Johs. Dana's Togt omkring Jorden 1928—1930. København, 1932.

SKATES AND RAYS

Ninni, E. Alcune Osservazioni sulla "*Raja naevus*" (Müll. Henl.) Notas y Resúmenes, Serie II, Núm. 59, Madrid, 1932.

Steven, G. A. Rays and Skates of Devon and Cornwall. II. A Study of the Fishery; with Notes on the Occurrence, Migrations and Habits of the Species. Journ. Mar. Biol. Assoc., N. S. XVIII, 1—34, Plymouth, 1932.

FRESHWATER FISH

Alm, G. Laxodlingens nytta. Ny Svensk Fiskeritidskrift, Nr. 12, 136—41, 1932.

Clemens, W. A. and L. S. Contribution to the Life-History of the Sockeye Salmon (No. 17). Report of the Commissioner of Fisheries for the year ended the 31st Dec. 1931, with Appendices, 13—37, Prov. Brit. Columbia, Victoria, 1932.

Lindsay, S. T. and Thompson, H. Biology of the Salmon (*Salmo salar* L.) taken in Newfoundland waters in 1931. Rep. Newfoundland Fishery Research Comm., Vol. I, No. 2, 1932.

Nall, G. H. Notes on Collections of Sea Trout Scales from Lewis, and Harris and from North Uist. Fishery Board for Scotland, Salmon Fisheries, 1932, No. I, Edinburgh, 1932.

Parrott, A. W. The Age and Growth of Trout in New Zealand (Paper No. 1). Fisheries Bull. No. 4, Marine Department, Wellington, 1932.

Pritchard, A. L. Pacific Salmon Migration. The Tagging of the Pink Salmon and the Chum Salmon in British Columbia in 1929 and 1930. Bull. Biol. Board of Canada, No. XXXI, Ottawa, 1932.

O'Donoghue, C. H. and Boyd, E. M. A Second Investigation of the Food of the Sea Trout (*Salmo trutta*). Fishery Board for Scotland, Salmon Fisheries, 1932, No. II, Edinburgh, 1932.

Oloffson, O. 1931 ett nyt smålaxår i ovre Norrland; bidrag till frågan om minimimått for lax. Ny Svensk Fiskeritidskrift, Nr. 11, 125—30, 1932.

Oloffson, O. Sikens tillväxt under en varm och en kall sommar. Ny Svensk Fiskeritidskrift, Nr. 14, 163—66, 1932.

Otterstrøm, C. V. Haderslev Dam. Ferskvandsfiskeribladet, XXX, Nr. 4—5, 1932. (In Danish, German Résumé.)

Otterstrøm, C. V. Turbinerne og de nedadvandrende Ungfisk af Laks og Ørred. I og II. Sports-Fiskeren, 7. Aargang, Nr. 1 and Nr. 7, Holstebro, 1932.

Rich, W. H. Salmon-Tagging Experiments in Alaska, 1930. Bull. Bureau of Fisheries, XLVII, 399—406, U. S. A. 1932.

Pollution.

Blegvad, H. Investigations of the Bottom Fauna at Outfalls of Drains in the Sound. Report Danish Biol. Stat., XXXVII, 1—20, Copenhagen, 1932.

Fraser, J. A. Observations on the Fauna and Constituents of an Estuarine Mud in a Polluted Area. Journ. Mar. Biol. Assoc., N. S. XVIII, 69—86, Plymouth, 1932.

Jensen, Aage J. C. Hydrographical Investigations of the Pollution of the Sound at Copenhagen. Report Danish Biological Stat., XXXVII, 21—34, Copenhagen, 1932.

Oysters and other Lamellibranchs.

Coe, W. R. Development of the Gonads and the Sequence of the Sexual Phases in the California Oyster (*Ostrea lurida*). Bull. Scripps Inst. Oceanography, La Jolla, California, Tech. Ser., III, 119—44, Berkeley, U. S. A. 1932.

Coe, W. R. Histological Basis of Sex Changes in the American Oyster. Science, LXXVI 125—27, New York, 1932.

Havinga, B. Austern- und Muschelkultur. Handbuch der Seefischerei Nordeuropas (Lübbert und Ehrenbaum), Band VII, Heft 5, Stuttgart, 1932.

McMillin, H. C. and Bonnot, P. Oyster Pests in California. California Fish and Game, Vol. XVIII, 147—48, U. S. A. 1932.

Spärck, R. Studies on the Biology of the Oyster in the Limfjord. IX. Report Danish Biol. Stat., XXXVII, 59—64, Copenhagen, 1932.

Spärck, R. and Lange, E. Preliminary Investigation of the Content of Bacteria in the Limfjord Oyster. Report Danish Biol. Stat., XXXVII, 69—73, Copenhagen, 1932.

Stephen, A. C. Notes on the Biology of some Lamellibranchs in the Clyde Area. Journ. Mar. Biol. Assoc., N. S. XVIII, 51—68, Plymouth, 1932.

Wright, F. S. Report of Investigations into the past and present condition of the Natural Oyster Beds of South Wales. Fishery Investigations, Series II, Vol. XII, No. 4, London, 1932.

Crustacea.

Nicol, E. A. T. The Feeding Habits of the Galatheidea. Journ. Mar. Biol. Assoc., N. S., XVIII, 87—106, Plymouth, 1932.

Whales and Seals.

Jenkins, J. T. Whales and Modern Whaling. London, 1932.

Ommanney, F. D. The Vascular Networks (Retia mirabilia) of the Fin Whale (*Balaenoptera physalus*). Discovery Reports, V, 327—62, Cambridge, 1932.

Ommanney, F. D. The Urino-Genital System of the Fin Whale (*Balaenoptera physalus*) with appendix. The Dimensions and Growth of the Kidney of Blue and Fin Whales. Discovery Reports, V, 363—466, Cambridge, 1932.

Biological-Miscellaneous.

Abbot, C. G. The Periodometer: An Instrument for finding and evaluating periodicities in long series of observations. Smithsonian Misc. Collections, Vol. 87, No. 4, Washington, D. C., U. S. A. 1932.

Huntington, E. Matamek Conference on Biological Cycles. Matamek Factory, Canadian Labrador, 1932.

Neu, W. Untersuchungen über den Schiffsbewuchs. Int. Rev. der gesamt. Hydrobiol. und Hydrogr. XXVII, 105—19, 1932.

Index to Volume VII.

ARTICLES

Page

Atkins, W. R. G. Solar Radiation and its Transmission through Air and Water 171
Buch, Kurt und Stina Gripenberg. Über den Einfluss des Wasserdruckes auf pH und das Kohlensäuregleichgewicht in grösseren Meerestiefen 233
Dannevig, Alf. The Influence of Light on the Cod..... 53
Dannevig, Alf. Is the Number of Vertebrae in the Cod influenced by Light or High Temperature during the Early Stages? 60
Devaputra, D., Thomas G. Thompson and Clinton L. Utterback. The Radioactivity of Sea Water..... 358
Dixon, Boris. The Mixture of Herrings with Sprats in Catches with the Sprat Trawl, and the Composition of the Sprat Stock of the Gulf of Danzig in 1932 386
Ekman, V. Walfrid. An improved Type of Current-Meter..... 1
Gran, H. H. Phytoplankton. Methods and Problems..... 343
Kändler, Rudolf. Unsicherheiten bei Bestimmung der Wirbelzahl infolge Verwachsungserscheinungen 373
Kreps, E. and N. Verjbinskaya. The Consumption of Nutrient Salts in the Barents Sea 25
Marmer, H. A. On the Classification of Tides..... 11
Nall, G. Herbert. The Spawning Mark on Sea Trout Scales: a Reply to Dr. Mottram's Criticisms 76
Otterstrøm, C. V. Die Turbinen und die abwärts wandernden jungen Lachse und Forellen..... 63
Riel, P. M. van. The Snellius Expedition..... 212
Rollefsen, Gunnar. The Susceptibility of Cod Eggs to external Influences 367
Russell, E. S. and H. O. Bull. A Selected Bibliography of Fish Behaviour 255
Soot-Ryen, T. Changes in the Nitrite Content through the Year in North-Norwegian Fjords..... 246
Storrow, B. Salmon Caught in the Vicinity of the Tyne, 1927—1931 396
Verjbinskava, N. Observations on the Nitrite Changes in the Barents Sea . 47
Witting, Rolf. A Current-Meter, its Use and some Results 218
Wolfe Murray, D. K. Tunny (*Thunnus thynnus* L.) in the North Sea 251

REVIEWS

Altnöder, K. Bericht über die III. und IV. Untersuchungsfahrt zur Feststellung des Vorkommens der Herbstheringslarven in den Laichperioden 1930 und 1931. Reviewed by Erik M. Poulsen 424
Berget, Alphonse. Leçons d'Océanographie Physique: 2me partie: L'Océan et l'Atmosphère. Reviewed by Jas. Johnstone 284

Page

Bhatia, D. On the Production of annual zones in the scales of the rainbow trout (*Salmo irideus*) I. Reviewed by H. Lissner 110

Böhnecke, G. Beiträge zur Ozeanographie des Oberflächenwassers in der Dänemarkstrasse und Irminger See. Teil I, zugleich Bericht über die Fahrt des "Meteors" im Sommer 1930. Reviewed by J. P. Jacobsen 284

Braarud, T. and B. Føyn. Beiträge zur Kenntnis des Stoffwechsels im Meere. Reviewed by H. W. Harvey 90

Braarud, Trygve and Alf Klem. Hydrographical and Chemical Investigations in the Coastal Waters off Møre and in the Romsdalsfjord. Reviewed by H. Wattenberg 286

Brooks, Charles F. Varying Trade Winds change Gulf-Stream Temperatures. Reviewed by O. von Schubert 288

Brotzky, V. A. Materials for the quantitative evaluation of the bottom fauna of the Storfjord (E. Spitzbergen). Reviewed by G. A. Steven 300

Butcher, R. W., F. T. K. Pentelow and J. W. A. Woodley. An Investigation of the River Lark and the Effect of Beet Sugar Pollution. Reviewed by A. C. Gardiner 427

Calderwood, W. L. Salmon Hatching and Salmon Migrations. Reviewed by H. Henking 108

California State Fisheries Laboratory. Studies of the Length Frequencies of the California Sardine (*Sardina caerulea*). Reviewed by W. C. Hodgson .. 425

Church, P. E. Surface temperatures of the Gulf Stream and its bordering Waters. Reviewed by O. van Schubert 414

Clark, G. H. The California Halibut (*Paralichthys californicus*) and an Analysis of the Boat Catches. Reviewed by T. Edser 301

Dawes, B. 1) Growth and Maintenance in the Plaice (*Pleuronectes platessa* L.). Part I. 2) A Statistical Study of Growth and Maintenance in the Plaice (*Pleuronectes platessa* L.). Part II. Reviewed by Å. Vedel Tåning 302

Defant, A. Bericht über die ozeanographischen Untersuchungen des Vermessungsschiffes "Meteor" in der Dänemarkstrasse und in der Irmingersee. Zweiter Bericht. Reviewed by H. U. Sverdrup 288

Ekman, V. W. Zum Probleme des Golfstromes. Reviewed by H. U. Sverdrup 289

Federighi, H. Studies on the Oyster Drill (*Urosalpinx cinerea*, Say). Reviewed by H. P. Sherwood 425

Ford, E. 1) Growth in Length during the Transition from Larva to Adolescent in the Pilchard and Sprat. 2) Changes in Length during the Larval Life and Metamorphosis of the Freshwater Eel (*Anguilla vulgaris* Turt). Reviewed by W. Schnakenbeck 306

Freundler, P. et M. Pilaud. Sur l'eau normale méditerranéenne. 1re Partie. Reviewed by Bruno Schulz 415

Friedrich, H. Mitteilungen über vergleichende Untersuchungen über den Lichtsinn einiger mariner Copepoden. Reviewed by G. M. Spooner 91

Frost, W. E. Observations on the Reproduction of *Nyctiphanes couchii* (Bell) and *Meganyctiphanes norvegica* (Sars) off the South Coast of Ireland. Reviewed by Marie V. Lebour 421

Gardiner, A. C. The Validity of Single Vertical Hauls of the International Net in the Study of the Distribution of the Plankton. Reviewed by Cl. Künne 91

Geissler, H. Tiefenmessung mit ungeschützten Thermometern. Reviewed by J. P. Jacobsen 289

Page

Gustafson, T. och B. Otterstedt. Svenska strömmätningar i Kattegatt 1930. Reviewed by E. Palmén 291
Gutsell, James S. Natural History of the Bay Scallop. Reviewed by F. S. Wright 97
Hagmeier, A. Die Bodenfauna der Ostsee im April 1929 nebst einigen Vergleichen mit April 1925 und Juli 1926. Reviewed by J. A. Robertson 94
Hagmeier, A. Eine Fluktuation von *Mactra* (*Spisula*) *subtruncata* da Costa an der ostfriesischen Küste. Reviewed by J. A. Robertson 95
Harvey, H. W. Hydrography of the Mouth of the English Channel, 1925—1928. Reviewed by J. N. Carruthers 408
Heape, W. Emigration, Migration and Nomadism. Reviewed by C. F. Hickling 429
Hentschel, E. Die biologischen Methoden und das biologische Beobachtungsmaterial der "Meteor"-Expedition. Reviewed by P. Jespersen 418
Hickling, C. F. The Structure of the Otolith of the Hake. Reviewed by H. Lissner 308
Hjort, J., J. Lie and J. T. Ruud. Norwegian Pelagic Whaling in the Antarctic. I. Whaling Grounds in 1929—1930 and 1930—1931. Reviewed by N. A. Macintosh 426
Hopfner, F. Die Gezeiten der Meere. Reviewed by J. Proudman 87
Hopkins, A. E. Temperature and the Shell Movements of Oysters. Reviewed by H. M. Webb 114
Huntsman, A. G. The Maritime Salmon of Canada. Reviewed by R. Southern 106
Idelson, M. S. A preliminary quantitative evaluation of the bottom fauna of the Spitzbergen Bank. Reviewed by G. A. Steven 300
Iselin, C. A Report on the Coastal Waters of Labrador. Based on explorations of the "Chance" during the Summer of 1926. Reviewed by D. J. Matthews 413
Jensen, Aage, J. C. Investigations of the Plaice Stock in the Southern Horns Reef Area in the Years 1928—1930. Reviewed by D. E. Thursby-Pelham 99
Jensen, A. S. og P. M. Hansen. Undersøgelser over den grønlandske torsk (*Gadus callarias* L.). Reviewed by Oscar Sund 104
Johansen, A. C. The Sprat (*Clupea sprattus* L.) in the Limfjord. Reviewed by J. A. Robertson 309
Knight, M. and M. W. Parke Manx Algae: an Algal Survey of the South End of the Isle of Man. Reviewed by A. D. Cotton 421
Kokubo, S. and T. Tamura. A Quantitative Investigation of the Plankton of Aomori Bay, as Studied Comparatively by Pump and Net Collection. Reviewed by A. C. Gardiner 293
Krogh, A. Dissolved Substances as Food of Aquatic Organisms. Reviewed by C. M. Yonge 313
Lambert, L. Les gisements huîtriers de la baie du Mont Saint-Michel. Reviewed by H. P. Sherwood 318
Lyman Duff, G. Factors involved in the Production of Annual Zones in the Scales of the Cod (*Gadus callarias* Linn.). Reviewed by W. C. Hodgson 305
Marshall, S. M. and A. P. Orr. A Study of the Spring Diatom Increase in Loch Striven. Reviewed by Cl. Künne 295
Nall, G. H. The Life of the Sea Trout. Reviewed by R. Southern 317
Needler, A. B. The Haddock. Reviewed by Erik M. Poulsen 422
Nelson, Thurlow C. and Earle B. Perkins. Studies of the Movements and of the Distribution of Oyster Larvae in Natural Waters of New Jersey, and

Page

a Study of Oyster Problems in Barnegat Bay. Reviewed by H. P. Sherwood 114
Newbigin, M. Life by the Seashore; an Introduction to Natural History. Rewritten and revised by R. Elmhirst. Reviewed by Marie V. Lebour 113
Norman, J. R. A History of Fishes. Reviewed by L. Joubin 111
O'Donoghue, C. H. and E. M. Boyd. A Preliminary Investigation of the Food of the Sea Trout (*Salmo trutta*). Reviewed by F. T. K. Pentelow 111
Palmén, E. Untersuchungen über die Strömungen in den Finnland umgebenden Meeren. Reviewed by H. Thorade 85
Peters, N. Die Bevölkerung des Südatlantischen Ozeans mit Ceratien. Reviewed by Marie V. Lebour 419
Pettersson, Otto. The Tidal Force. A Study in Geophysics. Reviewed by H. A. Marmer 87
Regnart, H. C. The lower limits of perception of electrical currents by fish. Reviewed by J. A. Bierens de Haan 105
Ricketts, N. G. and P. D. Trask. The Bathymetry and Sediments of Davis Strait. The "Marion" Expedition to Davis Strait and Baffin Bay. Scientific Results, Part I. Reviewed by A. Kiilerich 409
Roule, L. Les poissons et le monde vivant des eaux. IV. Les oeufs et les nids. Reviewed by H. O. Bull 113
Russell, F. S. The Vertical Distribution of Marine Macroplankton. X. Notes on the Behaviour of Sagitta in the Plymouth Area. Reviewed by G. P. Farran 92
Ruud, Johan T. On the Biology of Southern Euphausiidae. Reviewed by E. Hentschel 296
Sandström, J. W. Der Golfstrom und das Wetter. Reviewed by C. E. P. Brooks 89
Savage, R. E. The Relation between the Feeding of the Herring off the East Coast of England and the Plankton of the Surrounding Waters. Reviewed by P. Jespersen 310
Schiller, J. Über autochthone pflanzliche Organismen in der Tiefsee. Reviewed by E. Hentschel 93
Schmidt, Johs. Race Investigations X. The Atlantic Cod (*Gadus callarias* L.) and local races of the same. Reviewed by Oscar Sund 103
Schnakenbeck, W. Zum Rassenproblem bei den Fischen. Reviewed by Anton Fr. Bruun 100
Schubert, O. von. Zur Frage der Stabilität in grossen Meerestiefen bei Temperaturumkehr. Reviewed by P. M. van Riel 292
Sklower, A. Die Tierwelt vor der samländischen Ostseeküste und ihr Zusammenschluss zu Lebensgemeinschaften. Reviewed by J. A. Robertson 96
Smith, E. H. The "Marion" Expedition to Davis Strait and Baffin Bay under the direction of the United States Coast Guard. Scientific Results Part 3. Arctic Ice, with especial Reference to its Distribution to the North Atlantic Ocean. Reviewed by D. J. Matthews 410
Spooner, G. M. Some observations in schooling in fish. Reviewed by J. A. Bierens de Haan 106
Storrow, B. and D. Cowan. Herring Investigations. 1. Herring Shoals. 2. Size. Reviewed by G. P. Farran 312
Thompson, T. G. and R. van Cleve. Determination of the Chlorinity of Ocean Waters. Reviewed by Bruno Schulz 417
Thorade, H. Strömungen und Zungenförmige Ausbreitung des Wassers. Reviewed by H. U. Sverdrup 415

Page

THORADE, H. Probleme der Wasserwellen. Reviewed by HAROLD JEFFREYS.... 417

VOISIN, P. Recherches sur la reproduction des huîtres indigènes dans le Morbihan. Reviewed by H. P. SHERWOOD 319

WEYMOUTH, F. W. and H. C. MCMILLIN. Relative Growth and Mortality of the Pacific Razor Clam (*Siliqua patula* Dixon) and their bearing on the commercial fishery. Reviewed by F. S. WRIGHT 98

WEYMOUTH, F. W. and SETON H. THOMPSON. The Age and Growth of the Pacific Cockle (*Cardium corbis* Martyn). Reviewed by F. S. WRIGHT 98

WILLER, A. Vergleichende Untersuchungen an Strandgewässern. Reviewed by G. A. STEVEN 315

WORTHINGTON, E. B. Vertical movements of fresh-water Macroplankton. Reviewed by A. C. GARDINER 297

ZENKEWITSCH, L. A. A quantitative evaluation of the bottom fauna in the sea region about the Kanin peninsula. Reviewed by G. A. STEVEN 300

NOTES AND CORRESPONDENCE

Obituary Notice:—

NIELSEN, J. N. (1877—1932) by OVE PAULSEN 339

Notes and Correspondence:—

The Spawning Mark on Sea Trout Scales. W. I. M. MENZIES..... 81

Publication of "Der Seewart" by the "Deutsche Seewarte" 84

A Guide to Fish Marks used by the Members of the International Council for the Exploration of the Sea, and by some non-participant Countries 133, 321 and 407

CURRENT BIBLIOGRAPHY

Current Bibliography prepared by the Editor with the assistance of Miss THURSBY-PELHAM ..... 116, 322 and 431

Notice to Contributors.

1) All contributions should be type-written, on one side of the paper only.

2) Drawings and diagrams for reproduction should be prepared in waterproof Indian Ink (Encre de Chine) on Bristol Board or other perfectly smooth, white paper or card. No erasures should be made. Shading should be limited to the minimum necessary, and when used the shading lines should be kept open. Fine and dotted lines should be drawn boldly.

Lettering should be inserted only in pencil: the block-maker will be responsible for the definitive lettering.

Drawings should if possible be twice the diameter required, and when reduced should occupy a maximum space of 18 cms. in length and 11 cms. in width, including the space for the legend. The shape should be such as to fit easily into the page.

The size to which drawings are to be reduced should be noted in pencil on the originals.

When several illustrations are required for the same article they may be drawn on the same sheet, allowing at least 5 cms. between them.

Charts and curves may be drawn to advantage on graph-paper ruled in pale blue lines, as these lines do not appear in photographic reproduction.

Legends for figures should be type-written on a separate sheet.

3) For satisfactory reproduction of photographs a good glossy bromide print is required, and all added matter, such as reference letters, arrows, numbers etc., should be drawn on the face of the photograph or indicated on tracing paper attached to the back of the print and folded over the front. If matter is written on the face of the photograph a duplicate print without the added matter should be supplied.

Legends should be written on the back of the photographs, or type-written on a separate sheet.

ELLIOTT & GARROOD LTD.

MANUFACTURERS OF HYDROGRAPHIC APPLIANCES

BECCLES - SUFFOLK - ENGLAND

Telegrams: Elliott Garrood, Beccles.
Telephone: Beccles 7.

"CARRUTHERS" DRIFT INDICATORS · WATER SAMPLING BOTTLES
"LUMBY" SURFACE SAMPLERS · RECORDING METRE WHEELS
"HARDY" PLANKTON INDICATORS . WINCHES FOR HYDROGRAPHIC WORK

Designs and Quotations for any special apparatus.

BERGEN NAUTIK

Instrument Makers, Bergen, Norway.

Great experience in oceanographic instruments, e. g.

NANSEN WATERBOTTLES, (with latest improvements), various sizes,
METRE WHEELS, (periph. 1/2 or 1 m), also with large DISTANCE DIALS, DYNAMOMETERS, THERMOMETER COMPARISON FRAMES (taking 10 therm.), GROUND SAMPLERS, PLANKTON NET BUCKETS and RELEASING MECHANISMS, FISHERMEN'S THERMOMETERS, FISHERMEN'S SOUNDING GEAR, THOMPSON SOUNDING GEAR
OCEANOGRAPHIC WINCHES (el. driven).

We have supplied all Norwegian and many foreign institutions.
MODERATE PRICES. Please write for illustrated catalogue, including list of principal customers.

J. SOLBERG HANSEN

BERGEN - NORWAY

OPTICIAN AND INSTRUMENT MAKER

Sole manufacturer of the following instruments for research ships and oceanographical laboratories.

1) SUND'S OCEANOGRAPHICAL SLIDE RULE for easy and accurate calculation of sp. volume and density of sea water, directly from temperature and burette reading. In use in 10 laboratories and ships in five countries. Descr. in this journal, vol. IV, nr. 1. Price kr. 275.-
2) SUND'S COLORIMETER, designed for easy and accurate determination of phosphates, nitrates, nitrites, pH etc. in sea water. Can be used easily in any state of sea. Glass parts restricted to absolute minimum. Price 300-400 kr. according to extent of outfit.
3) LEA'S PLANKTON SAMPLE DIVIDER. For accurate subdivision of non-homogeneous plankton samples into 10 equal parts, whatever be the sp. gr. of the diff. constituents. Price kr 200.

Publications of the International Council: —

RAPPORTS ET PROCÈS-VERBAUX,

Vol. LXXV: *General Marine Physiology. Conditions of Growth of Phytoplankton.* September 1931. Kr. 2.75.

Vol. LXXVI: *The Mixing Question, viewed theoretically and practically together with a consideration of Internal Waves.* September 1931. Kr. 2.50.

Vol. LXXVII: *Rapport Atlantique 1930.* Janvier 1932. Kr. 3.50.

BULLETIN HYDROGRAPHIQUE pour l'Année 1930. October 1931. Kr. 3.25.

BULLETIN STATISTIQUE pour l'Année 1929. September 1931. Kr. 3.25.

Attention is drawn to the new Series E: —

FAUNE ICHTHYOLOGIQUE DE L'ATLANTIQUE NORD, of which Nos 1—8 have been issued. Each 4 Kr.

FRANZ SCHMIDT

BERLIN N4
WÖHLERTSTRASSE 20

FABRIKANT VON
TIEFSEE-UMKIPPTHERMOMETER
MIT NEBENTHERMOMETER
EINFACHE KIPP-THERMOMETER
FÜR DIE FISCHEREI
OBERFLÄCHEN-THERMOMETER
UND ANDERN ARTEN

MANUFACTURERS OF
DEEP-SEA REVERSING THERMOMETERS
WITH AUXILIARY THERMOMETERS
PLAIN REVERSING THERMOMETERS
FOR FISHERMEN
SURFACE AND OTHER THERMOMETERS

GEGRÜNDET 1912 — FOUNDED IN 1912

Table of Contents.

Page

1. Obituary Notice:—
   J. N. Nielsen (1877—1932); by Ove Paulsen 339
2. H. H. Gran. Phytoplankton. Methods and Problems..... ~~448~~ 343
3. D. Devaputra, Thomas G. Thompson and Clinton L. Utterback. The Radioactivity of Sea Water..... 358
4. Gunnar Rollefsen. The Susceptibility of Cod Eggs to external Influences 367
5. Rudolf Kändler. Unsicherheiten bei Bestimmung der Wirbelzahl infolge Verwachsungserscheinungen 373
6. Boris Dixon. The Mixture of Herrings with Sprats in Catches with the Sprat Trawl, and the Composition of the Sprat Stock of the Gulf of Danzig in 1932 386
7. B. Storrow. Salmon caught in the Vicinity of the Tyne, 1927—1931..... 396
8. Notice of Fish Marking to be carried out by the Hayatomo Fisheries Institute, Tobata-Shi, Japan 407
9. Reviews..... 408
10. Current Bibliography prepared by the Editor with the assistance of Miss Thursby-Pelham..... 431

BIANCO LUNO A/S — COPENHAGEN